January

25 cents

Science and Invention

FORMERLY
ELECTRICAL EXPERIMENTER

NEWSPAPER

As a Radio

LOUD TALKER

See Page 858

Electricity Needs You

I WILL TRAIN YOU AT HOME

Stop right here. This is YOUR opportunity! Electricity is calling you, and the Electrical Business is in for a tremendous increase. But it needs more trained men—at big pay. By my **Home Study Course** in **Practical** Electricity I can train you for these positions.

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BE A BIG PAID

ELECTRICAL EXPERT

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You have the ambition and I will give you the training, so **get busy.** I am offering you **success** and all that goes with it. Will you take it? I'll make you an ELECTRICAL EXPERT. I will train you as you should be trained. I will give you the benefit of my advice and 20 years of engineering experience and help you in every way to the biggest possible success.

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Chicago Engineering Works
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CHICAGO, ILL.

Dear Sir: You may send me entirely free and fully prepaid, a copy of your book, "How to Become an Electrical Expert," and particulars about your **Home Study Course in Electricity.**

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Address.....

City..... State.....

Occupation..... Age.....

Valuable Book Free My book, "How to Become an Electrical Expert," has started many a man on the way to fortune. I will send a copy, free and prepaid, to every person answering this advertisement.

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CHICAGO ENGINEERING WORKS
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F R E E !

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A fine outfit of Electrical Tools, Instruments, Materials, etc., absolutely FREE to every student. I will also send you FREE and fully prepaid—Proof Lessons to show you how easily you can learn Electricity and enter this splendid profession by my new, revised and original system of Training by Mail.

RADIO COURSE FREE

Special newly-written wireless course worth $45.00 given away *free.*

Free Use of Laboratory

I have a large splendidly equipped Electrical Laboratory where you can come at any time for special instruction without charge. Several competent assistants—practical engineers—are in charge.

Earn Money While Learning

I give you something you can use *now.* Early in my *Home Study Course* I show you how to begin making money in Electricity, and help you get started. No need to wait until the whole course is completed. Hundreds of students have made several times the cost of their course in spare time work while learning.

The Cooke trained man is the "Big-Pay" man

In every man's life there is one Big Moment when he makes the decision that either robs him of success—or leads on to fortune.

Your One Chance to Earn *The Biggest Money of Your Life!*

HAVE you ever considered why our richest men come from our poorest boys? Isn't it a strange thing that it is almost invariably a young fellow who starts life without a cent in the world, without education, without influential friends—in short, without one single solitary advantage—who accumulates millions of dollars? Isn't it a miracle that inside of a comparatively few years a man can rise from abject poverty to fabulous wealth?

Astonishing, certainly—but more important, it is wonderfully inspiring. For it means that no man need be held down by circumstances. Once he knows the "millionaire's secret," he can put it into operation regardless of all obstacles that seem to block his path. His fancied handicaps simply vanish into thin air. He suddenly finds that everything he touches turns to gold—money flows in upon him—fortune showers him with its favors. Everything he wants seems to come to him just as surely and easily as day comes after night.

The Secret that Makes Millionaires

But millionaires are not the only ones who use this secret. It has made every great man of history. Think of Napoleon—an unknown Corsican soldier in the ranks—then suddenly startling the world with his meteor-like rise, overthrowing empires, reshaping the destinies of nations!

What is this amazing secret that can work such wonders? It is just this: *The thing behind all big achievement, whether in business, political or military life, is opportunity.* The man who wins is the man who sees his opportunity and seizes it. The man who never rises above the rut is the man who lets his opportunity pass.

To every man there comes one BIG opportunity—the golden chance of his life. And in the moment he decides for or against that opportunity—whether he will seize it or let it pass—he decides the whole future course of his life.

How often you hear a man say: "If only I had recognized my opportunity when it came—if only I had taken advantage of it—I would be a rich man today."

The world is full of such men—they plod along year after year—slaving away, hoping that somehow things will take a turn for the better. But their chance for success is gone—it lies buried in the graveyard of neglected opportunity.

On the other hand, let a man see and grasp his Big Opportunity—no matter how obscure he may be, how poor, how lacking in advantage—and his sudden rise to success will astonish the world. People will gasp at the amazing transformation in his fortunes. Read the life of any millionaire and you will find this to be so.

Choose Between Low Pay and Magnificent Earnings

This very minute *you* may be face to face with *your* Big Opportunity—your *one* chance to earn the biggest money of your life! Right now your decision may mean the difference between a life of plodding, routine work at low pay and a career of inspiring success and magnificent earnings.

For now you are offered the very opportunity that has made other men rich, that has brought them more money than they ever dreamed of earning.

It is the same opportunity that lifted Warren Hartle, of Chicago, out of a job in the railway mail service, where in ten years he had never gotten beyond $1,600 a year, and landed him in a $10,000 a year job. It jumped Charles Berry, of Winterset, Iowa, from $60 a month as a farmhand, to $1,000 a month. It brought to C. W. Campbell, of Greensburg, Pa., a clerk on the railroad, a position that paid him $1,562 in thirty days.

These men and hundreds more have found their Big Opportunity in the wonderful field of Salesmanship. They are all Master Salesmen now. They are earning the biggest money of their lives—more than they ever thought possible—they are engaged in the most fascinating work in the world—they are independent, come and go as they please—they meet big men—every minute of the day is filled with thrilling variety.

Your Big Opportunity may be here, too, in the wonder field of Salesmanship. Perhaps you say you have never even thought of becoming a Salesman. But before you decide one way or the other, examine the facts for yourself. See what Salesmanship offers you—why it is the best paid of all vocations—why there is no limit to what you may earn. Read the amazing proof that, no matter what you are doing now, you can quickly become a Master Salesman in your spare time at home—read how the National Salesmen's Training Association in its nation-wide search for men to fill the great need of Salesmen, has devised a wonderful system that reveals to you every Secret of Selling without interfering in the least with your present work. See how this famous organization helps you to a good position in the line of Selling you are best fitted for.

The opportunity that the N. S. T. A. offers you may be your *one* chance to earn the biggest money of your life, as it has been for hundreds of others. But whatever you do, don't pass it by without getting the facts.

Facts that Will Amaze You —Sent FREE

Mail the coupon below. This will not cost you a penny—it places you under no obligation. It simply means that you will receive, entirely FREE, a wonderful, illustrated Book, "Modern Salesmanship," and Proof that you can be a Master Salesman. You will receive, also, the personal stories of men throughout the country who to-day are enjoying magnificent success and earning five, ten and fifteen times as much money as ever before.

Send NOW—this minute may be the turning-point in your life. Address,

National Salesmen's Training Association

Dept. 42-A Chicago, Ill.

NATIONAL SALESMEN'S TRAINING ASS'N
Dept. 42-A, Chicago, Ill.

I simply want to see the facts. Send me FREE your Book "Modern Salesmanship" and Proof that I can become a Master Salesman. Also tell how you can help me to a position and send list of lines with openings for Salesmen.

Name .....

Address .....

City ..... State .....

Age ..... Occupation .....

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Science and Invention

FORMERLY

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No. 9

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A Startling Memory Feat That You Can Do

How I learned the secret in one evening. It has helped me every day

WHEN my old friend Faulkner invited me to a dinner party at his house, I little thought it would be the direct means of getting me a one-hundred-and-fifty per cent. increase in salary. Yet it was, and here is the way it all came about:

Toward the close of the evening things began to drag a bit, as they often do at parties. Finally some one suggested the old idea of having everyone do a "stunt." Some sang, others forced weird sounds out of the piano, recited, told stories, and so on.

Then it came to MacDonald's turn. He was a quiet sort of chap, with an air about him that reminded one of the old saying that "still waters run deep." He said he had a simple "stunt" which he hoped we would like. He selected me to assist him. First he asked to be blindfolded securely to prove there was no trickery in it. Those present were to call out twenty-five numbers of three figures each, such as 161, 249, and so on. He asked me to write down the numbers as they were called.

This was done. MacDonald then astounded everyone by repeating the entire list of twenty-five numbers backwards and forwards. Then he asked people to request numbers by positions, such as the eighth number called, the fourth number, and so on. Instantly he repeated back the exact number in the position called. He did this with the entire list—over and over again, without making a single mistake.

Then MacDonald asked that a deck of cards be shuffled and called out to him in their order. This was done. Still blindfolded, he instantly named the cards in their order backwards and forwards. And then, to further amaze us, he gave us the number of any card counting from the top, or the card for any number.

You may well imagine our amazement at MacDonald's remarkable feat. You naturally expect to see a thing of this sort on the stage, and even then you look upon it as a trick. But to see it done by an everyday business man, in plain view of every one, blindfolded and under conditions which make trickery impossible, is astonishing to say the least.

* * * * * *

ON the way home that night I asked MacDonald how it was done. He said there was really nothing to it—simply a memory feat, the key to which anyone could easily learn in one evening. Then he told me that the reason most people have bad memories is because they leave memory development to chance. Anyone could do what he had done, and develop a good memory, he said, by following a few simple rules. And then he told me exactly how to do it. At the time I little thought that evening would prove to be one of the most eventful in my life, but such it proved to be.

What MacDonald told me I took to heart. In one evening I made remarkable strides toward improving my memory and it was but a question of days before I learned to do exactly what he had done. At first I amused myself with my new-found ability by amazing people at parties. My "memory-feat," as my friends called it, surely made a hit. Everyone was talking about it, and I was showered with invitations for all sorts of affairs. If anyone were to ask me how quickly to develop social popularity, I would tell him to learn my memory "feat"—but that is apart from what I want to tell you.

The most gratifying thing about the improvement of my memory was the remarkable way it helped me in business. Much to my surprise I discovered that my memory training had literally put a razor edge on my brain. My brain had become clearer, quicker, keener. I felt that I was fast acquiring that mental grasp and alertness I had so often admired in men who were spoken of as "wonders" and "geniuses."

The next thing I noticed was a marked improvement in my conversational powers. Formerly my talk was halting and disconnected. I never could think of things to say until the conversation was over. And then, when it was too late, I would always think of apt and striking things I "might have said." But now I can think like a flash. When I am talking I never have to hesitate for the right word, the right expression or the right thing to say. It seems that all I have to do is to start to talk and instantly I find myself saying the very thing I want to say to make the greatest impression on people.

It wasn't long before my new-found ability to remember things and to say the right thing at the right time attracted the attention of our president. He got in the habit of calling me in whenever he wanted facts about the business. As he expressed himself to me, "You can always tell me instantly what I want to know, while the other fellows annoy me by dodging out of the office and saying, 'I'll look it up.'"

* * * * * * *

I FOUND that my ability to remember helped me wonderfully in dealing with other people, particularly in committee meetings. When a discussion opens up, the man who can back up his statements quickly with a string of definite facts and figures usually dominates the others. Time and again I have won people to my way of thinking, simply because I could instantly recall facts and figures. While I am proud of my triumphs in this respect, I often feel sorry for the ill-at-ease look of the other men who cannot hold up their end in the argument because they cannot recall facts instantly. It seems as though I never forget anything. Every fact I now put in my mind is as clear and as easy to recall instantly as though it were written before me in plain black and white.

We all hear a lot about the importance of sound judgment. People who ought to know say that a man cannot begin to exercise sound judgment until he is forty to fifty years of age. But I have disproved all that. I have found that sound judgment is nothing more than the ability to weigh and judge facts in their relation to each other. Memory is the basis of sound judgment. I am only thirty-two but many times I have been complimented on having the judgment of a man of forty-five. I take no personal credit for this—it is all due to the way I trained my memory.

* * * * *

THESE are only a few of the hundreds of ways I have profited by my trained memory. No longer do I suffer the humiliation of meeting men I know and not being able to recall their names. The moment I see a man his name flashes to my mind together with a string of facts about him. I always liked to read, but usually forgot most of it. Now I find it easy to recall what I have read. Another surprising thing is that I can now master a subject in considerably less time than before. Price lists, market quotations, data of all kinds, I can recall in detail almost at will. I rarely make a mistake.

My vocabulary, too, has increased wonderfully. Whenever I see a striking word or expression, I memorize it and use it in my dictation or conversation. This has put a remarkable sparkle and pulling power into my conversation and business letters. And the remarkable part of it all is that I now do my day's work quicker and with much less effort simply because my mind works like a flash and I do not have to keep stopping to look things up.

All this is extremely satisfying to me, of course. But the best part of it all is that since my memory power first attracted the attention of our president, my salary has steadily been increased. Today it is many times greater than it was the day MacDonald got me interested in improving my memory.

* * * * * * * * * * *

WHAT MacDonald told me that eventful evening was this: "Get the Roth Memory Course." I did. That is how I learned to do all the remarkable things I have told you about. The Publishers of the Roth Memory Course—The Independent Corporation—are so confident that it will also show you how to develop a remarkable memory that they will gladly send the Course to you on approval.

400,000

people have paid $5 or $7 for one of our Self-Improvement Courses—and remember no one was asked to pay until he had five days to examine the course in his own home.

Until the Independent Corporation published the "Roth Memory Course," "Paragon Shorthand," "Mastery of Speech," "Drawing, Art and Cartooning," "Reading Character at Sight," "How to Write Stories," "Super-Salesmanship," and other personal development courses, where could anyone buy similar courses for less than $15 to $75?

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So confident is the Independent Corporation, the publishers of the Roth Memory Course, that once you have an opportunity to see in your own home how easy it is to discover in a few short hours how to double, yes, triple your memory power, that they are willing to send the course on free examination.

Don't send any money. Merely mail the coupon or write a letter and the complete course will be sent, all charges prepaid, at once, so that you may take advantage of the special price and save $2.00. If you are not entirely satisfied send it back any time within five days after you receive it and you will owe nothing.

On the other hand, if you are as pleased as are the thousands of other men and women who have used the course, send only $3 in full payment. You take no risk and you have everything to gain, so mail the coupon now before this remarkable offer is withdrawn. Independent Corporation, Dept. R-1101, 15 West 37th Street, New York.

FREE EXAMINATION COUPON

Independent Corporation
Dept. R-1101, 15 West 37th Street, New York

Gentlemen—Please mail me the Roth Memory Course for 5 days' free trial. If I decide to keep it I will remit $3, the Special Price. Otherwise I will return it to you. It is understood that this coupon puts me under no obligation whatsoever.

Name .....

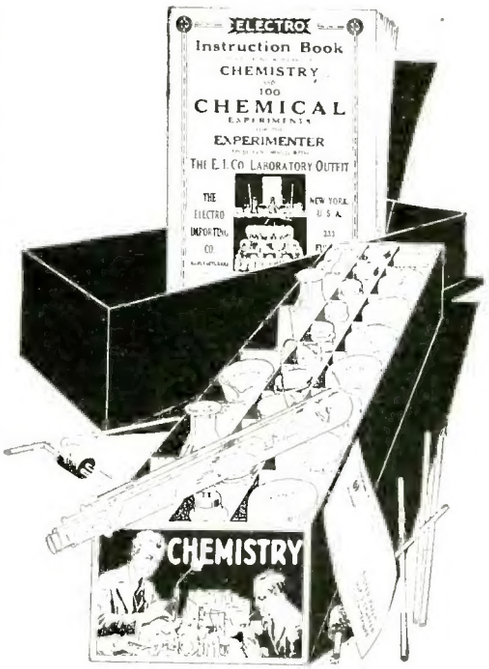
Address .....

Sc. & Inv. 1-23

A Chemistry Laboratory for $7.00

Think of it, fellows! Here is a real chemistry outfit with regular chemical apparatus that performs those fascinating, actual chemical experiments.

This outfit is not a toy, put up merely to amuse, but a practical laboratory set, with all the chemicals, apparata and reagents necessary to perform real work and to teach the beginner all the secrets of inorganic chemistry. With this outfit we give free a book containing a Treatise in Elementary Chemistry, useful data and recipes, and 100 instructive amusing experiments.



DESCRIPTION OF THE OUTFIT

The outfit consists of forty-four (44) chemicals all C. P. (chemical pure) put up in appropriate wooden boxes, glass bottles and hermetically closed jars. The acids are put up in glass bottles, with ground-in glass stoppers, and there is a sufficient quantity of chemicals supplied (mostly one to two ounces) enough to make dozens of experiments with each.

The apparata furnished are all of the best obtainable make and of standard laboratory size and shape. 17 pieces of apparata furnished with this outfit.

The instruction book is a real Chemistry Course for the Beginner. Some of the Contents are: Division of Matter: This is a Treatise on Elementary Chemistry, and deals with the theory of the Elements, Molecules and Atoms, etc.

100 EXPERIMENTS

How to make chemical tricks: how to make invisible and magic inks; how to test flour: how to test soil: how to make chlorine gas and smoke (German War Gas); how to bleach cloth and flowers: how to produce oxygen and hydrogen; how to make chemical colors: how to test acids and alkalies, and hundreds of interesting hints and formulas.

$7.00

Every Fellow Wants the

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The Boy's Electric Toy contains: Enough material to make and complete over twenty-five different electrical apparatus without any other tools except a screwdriver furnished with the outfit. Student's chromic plunge battery, compass-galvanometer, solenoid, telephone receiver, electric lamp. Enough various parts, wire, etc., are furnished to make the following apparatus:

Electromagnet, electric cannon, magnetic pictures, dancing spiral, electric hammer, galvanometer, voltmeter, hook for telephone receiver, condenser, sensitive microphone, short distance wireless telephone, test storage battery, shocking coil, complete telegraph set, electric riveting machine, electric buzzer, dancing fishes, singing telephones, mysterious dancing man, electric jumping jack, magnetic geometric figures, rheostat erratic pendulum, electric butterfly, thermo electric motor, visual telegraph, etc., etc..

This does not by any means exhaust the list, but a great many more apparatus can be built actually and effectually.

With the instruction book we furnish one hundred experiments that can be made with this outfit, nearly all of these being illustrated with superb illustrations. No other materials, goods or supplies are necessary to perform any of the one hundred experiments or to make any of the 25 apparatus. Everything can be constructed and accomplished by the means of this outfit, two hands and a screwdriver.

The outfit contains 114 separate pieces of material and 24 pieces of finished articles ready to use at once.

We guarantee satisfaction.

The size over all the outfit is 14 x 9 x 2¾. Shipping weight, 8 pounds. "The Boy's Electric Toys" outfit as described, $7.00. Immediate shipment.

SEND FOR YOUR SET TODAY

REMEMBER

JUST CLIP THE COUPON—DON'T SEND MONEY

ELECTRO IMPORTING CO., 233 Fulton St., New York City

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233 Fulton St., New York.

Please send me by express THE CHEMICAL LABORATORY. If I don't like it I need not accept it. If I want it I only pay $7.00 plus the few cents express charge.

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S.&I. 1-23

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Free Proof

You Can Learn to Dance In One Evening at Home!

Why be a wallflower? Why miss most of the real fun when you can so easily learn to dance in a single evening right in the privacy of your own home?

Aren't they foolish to envy wonderful dancing ability when they could so easily and quickly learn to dance in their own home?

Week-end parties—little social affairs—formal and informal occasions—regular dances—the phonograph or orchestra going with toe-tickling music—couples whirling around, dancing the very latest steps—everybody happy, carefree, and having a fine time!

It's a shame for you not to know how to dance, when it is so easy to learn. Arthur Murray, America's greatest dancing teacher, has perfected a wonderful new method that enables you to learn any of the very latest dances in a few minutes—and to learn all of them in a few hours.

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Here's What a Few Say:

I am well satisfied that your way of teaching is best. I have taken lessons from dancing teachers in Huntington, W. Va., Chattanooga, Tenn., and Birmingham, Ala. Your instructions are better than the personal teachers, and thru your methods I am becoming a good dancer. I will do all in my power to get new pupils for you.

J. T. BERRY,
Anniston, Ala.

I want to tell you how wonderful your course is. I was taught by other dancing teachers, but I prefer your lessons because I accomplished more and learned more quickly thru your lessons than by other teachers. I am now enjoying myself very much, and advise all those who want to know the correct way of dancing to take your lessons. I am enjoying many pleasant hours.

E. P. MORRIS,
1495 Elgin Ave.,
Winnipeg, Manitoba, Can.

I am delighted with the lessons. People are amazed at the ease with which one grasps the idea from your directions. I feel grateful to you.

GRACE THREFALL,
Guler, Wash.

I have made use of all the instructions sent me and am well pleased with the course.

BEULAH ROGERS,
4457 Monroe Street, Chicago, Ill.

Your course has given me a good knowledge of dancing. I am getting along fine.

WILLIAM KOLICH,
Elizabeth, N. J.

I know your lessons pretty well. I attended a dance Thursday and got a compliment on my dancing. You know I never danced before and when I got into the ballroom I was the equal of them all. They sure were surprised.

ARMOND MAROHL,
Mayville, Wis.

I must say that your dancing course is just simply great! Last night was the first time I danced. I even danced with the best dancers around here, and they all marvelled at how well I danced.

HILDA WERTH,
Hampton, Neb.

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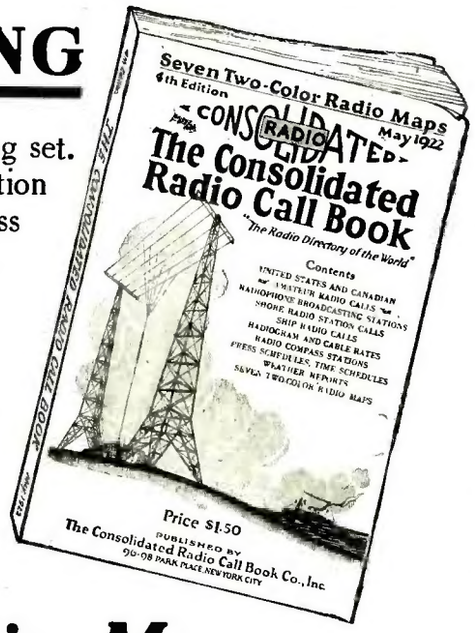

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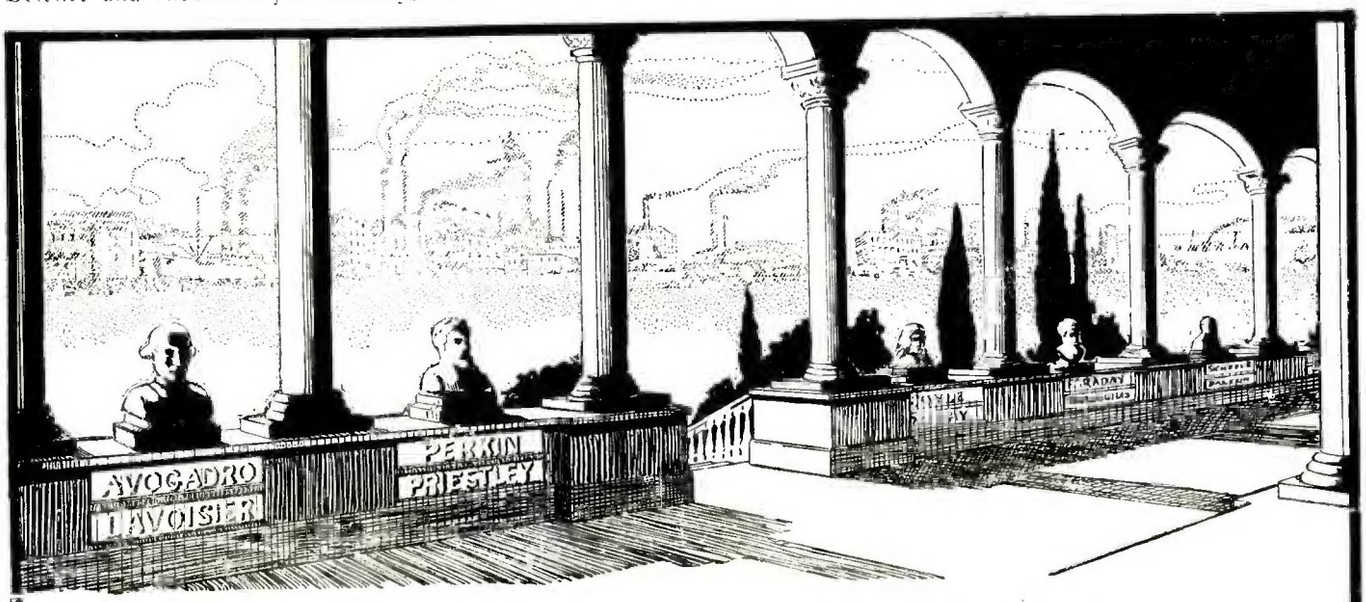

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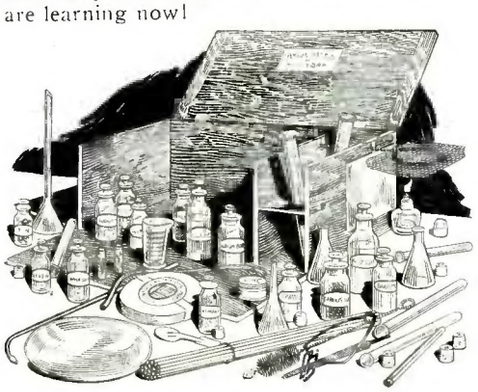

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Volume X
Whole No. 117

Science and Invention

JANUARY
1923
No. 9

H. GERNSBACK, EDITOR AND PUBLISHER
H. WINFIELD SECOR, ASSOCIATE EDITOR
T. O'CONOR SLOANE, Ph.D., ASSOCIATE EDITOR
Editorial and General Offices, – – – 53 Park Place, New York

"Those Who Refuse to Go Beyond Fact Rarely Get As Far As Fact"--HUXLEY

Solving the Heating Problem

THE winter heating problem is ever with us. We have mentioned before in the columns of this journal that the present way of heating our houses is archaic, and highly uneconomical. Now comes Professor Reginald A. Fessenden, who offers to demonstrate to the city of Boston that he can heat the houses of that city by electricity for the price it would cost to produce the same temperature if coal were selling at from $2.00 to $3.00 per ton.

This statement seems impossible at first blush, particularly when coal is selling for $12.00 to $15.00 per ton.

From Boston, let us say, to Scranton, the big coal center, is some 250 miles. The freight rate for a ton of coal is, roughly, $2.50. Now Fessenden offers to transport the same amount of calories over a wire, at the rate of about $1.00.

There is nothing new in this, and the idea of burning the coal at the mine, where the electric energy is generated and then transported over high tension lines, hundreds of miles away, is an old thought. The thing, however, has never been done on a grand scale, and there is, moreover, no reason why it should not be done at once. It will be seen that by this means we first do away with transportation of the coal. The plant can be right at the mouth of the mine, where large power plants can be located, and the coal can be fed into these plants with the same wagons that come from the interior of the mine, discharging the coal on conveyors and, therefore, doing away with all second, third, and more handlings of the same coal. The energy is then transmitted through comparatively thin wires to the distant centers. The lines are all high tension, of 250,000 volts and over, as the loss of energy in high tension lines is much smaller than in those of low tension. Strange to say, three such wires, although not thicker than your finger, would be able to heat all Boston, without the wires themselves even becoming warm.

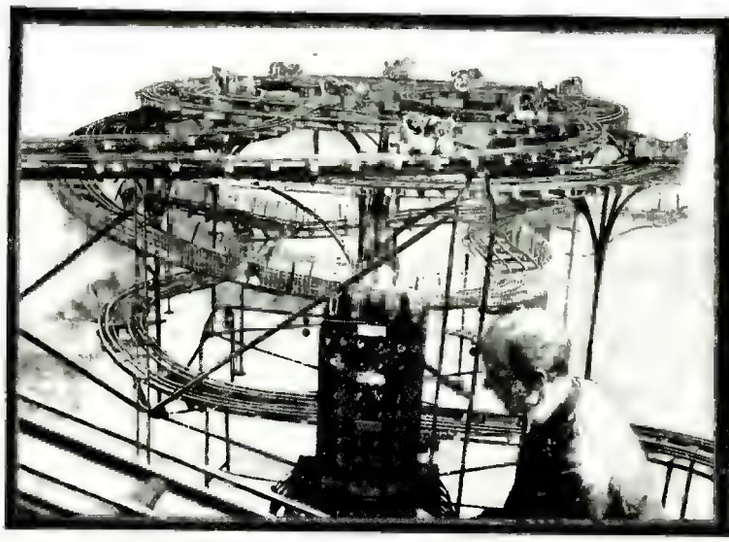
At the distant distribution center, let us say Boston, we step down with transformers the high tension circuit to 500, 220, or 110 volts, or any pressure that we wish to use.

Now heating houses by electricity does not at all mean that we are obliged to have the familiar open coil incandescent heater. Nothing of the sort. The present steam plants can remain. Our houses will be heated by steam or by hot air, the same as before, but instead of feeding coal into the furnace, we shall have electric coils that heat the water, so it will not be necessary to change any present-day installation. There are on the market now very efficient electric boilers, where metallic plates heat the water by direct contact. These electric boilers are highly efficient, as a matter of fact, much more efficient than coal boilers, which are always dependent upon the human agency, and are efficient only when there is a good fire. The minute the fire goes down low, the coal is burned just the same, but very little heating results. In other words, when we heat our houses today, by means of coal, much of the heat goes out through the chimney, and not into the radiators, where we want the heat. The electric boiler does away with all this, as there is no chimney used with the electric boiler. The heat goes exactly where you want it to, and that is into your radiators, or out of your heat registers.

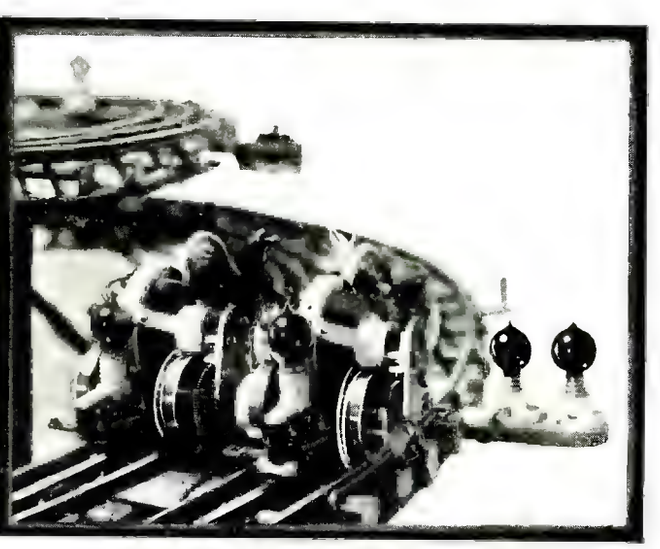
The future will no doubt see great changes in the heating of our houses. The present construction of our dwellings is scientifically all wrong, as we pointed out before in this journal. They are constructed wrong for summer use, and just as wrong for winter. In the summer our houses are hot—in the winter they are cold, for no reason at all. Our architects have still a lot to learn in physics. Slowly the thought is percolating through that a building built with solid walls is a monstrosity. A solid stone wall, particularly if reinforced with steel, is an excellent conductor of both heat and cold. When it becomes hot, the wall is hot; —when the temperature falls, in the wintertime, the walls and consequently the house are cold. If our architects would take the trouble to study a thermos bottle, they would soon change the construction of our dwellings. Slowly, bricks with air pockets are coming into use. This, however, is not enough. A Canadian engineer built a house along scientific lines, and heated it in the coldest winter with a total energy that represented less than the expenditure of ten tons of coal. The entire house was heated by electricity, and was comfortable at all times, notwithstanding the fact that in this particular section of Canada the temperature for a great part of the winter varies around 20 degrees below zero. The secret is in the walls, which were all double, the spaces between the walls having all been filled with cork dust, which is a notoriously poor conductor of heat. Air pockets were done away with entirely, and not only the walls, but the ceilings and the roof of the house were thus cork-insulated, on the principle of an ice box.

This, however, is only half the story. The important part is the construction of the windows. Our present day windows are wrong, both for winter and summer. Glass is a fairly good conductor of heat and cold. Moreover, the radiation which we get from our big glass windows is tremendous. A window should be constructed of two or three panes of glass, with air pockets between the panes. The panes should be about an inch, or even half an inch, apart from each other. If three such panes were used, we would have an ideal window, and our houses would become livable in the hottest, as in the coldest weather. In the summer we throw our windows wide open. This is a mistake. A small opening, to secure enough ventilation, is sufficient, the same as in winter. With triple glass insulation, the house would be cool in the summer and hot in the winter, and when electric heating comes into use more and more, such changes will surely be brought about. Our houses will then be far healthier to live in than they are at present.

H. GERNSBACK.



Above is shown a photograph of a very ingenious model of an amusement railway, in which all of the actions taking place in the larger machine may be observed. Note the introducing tracks at the very top.

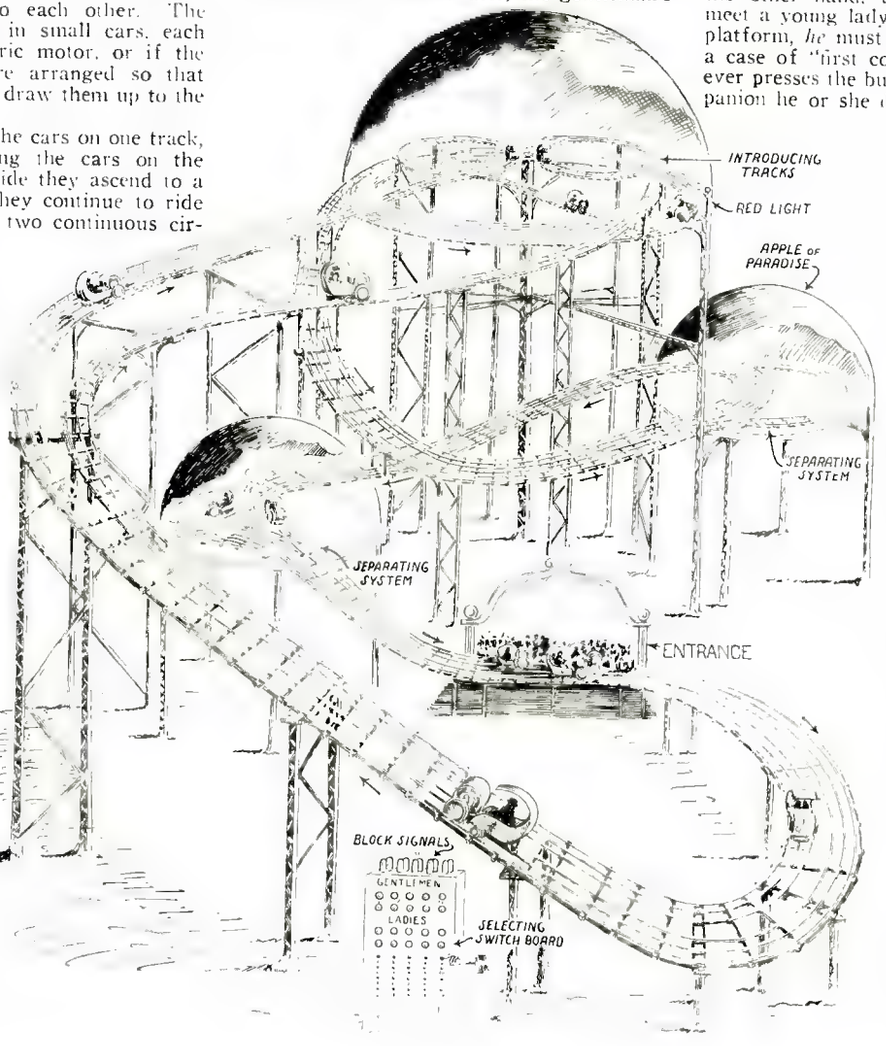


The amusement seekers having been properly introduced, meet in front of the block signals, where one car awaits the arrival of its companion. It is at this point that the cars are locked together, proceeding side by side on the rest of the journey.

The Paradise Railway

A NEW pleasure railway which is to be the most popular of any now gracing the many summer amusement resorts, will probably make its debut at Luna Park, Coney Island, during the coming summer season. This device differs materially from the many railways now found, in that it sanctions promiscuous "flirting" between individuals practically unknown to each other. The riders seat themselves in small cars, each equipped with an electric motor, or if the space permits, they are arranged so that a continuous cable will draw them up to the top of the track.

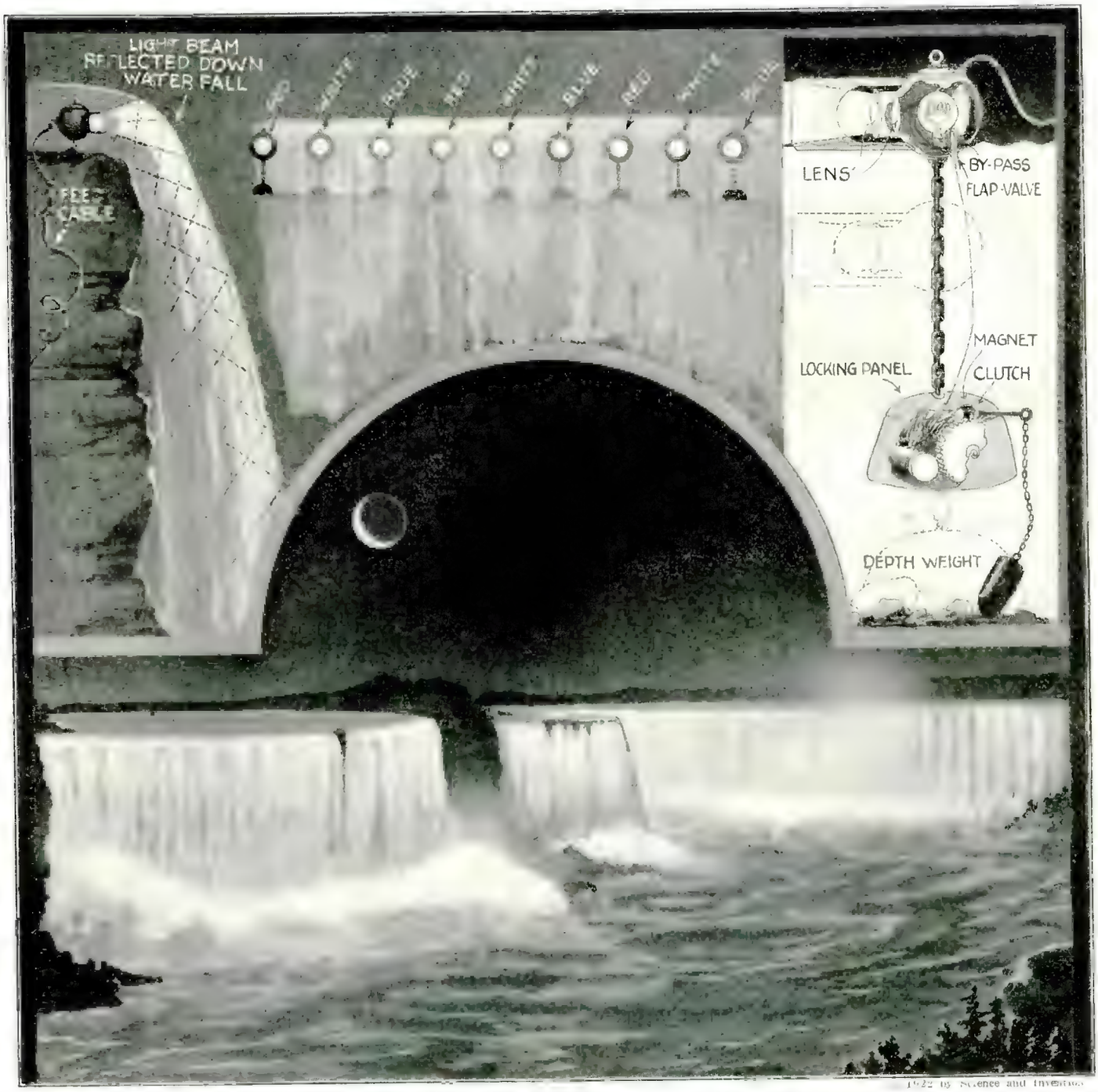
The girls occupy all the cars on one track, the gentlemen occupying the cars on the other track. Side by side they ascend to a lofty pinnacle, where they continue to ride around and around on two continuous circular tracks close to each other, the cars moving in opposite directions. Each of the cars is equipped with a selective mechanism in the form of a number of buttons indicated by numerals. Should the girl see a gentleman who would seem to be a pleasing companion, she presses the button corresponding to the number of his car. Immediately a light flashes at the master operator's switchboard, indicating that the patron in car No. 5, in which this young lady is riding, would like to meet the gentleman in car No. 6. So she is side-tracked and starts her downward course in the second part of the journey. At the same time or perhaps a fraction of a second later, the gentleman's car switches from the circular track and goes diving downward. The girl's car is stopped at the first block, until her male companion reaches her. An extension arm on his car now automatically lunges outward, and links the two cars together, and they go rambling along over the course of the paradise railway, side by side. If on the other hand, the gentleman desired to meet a young lady on the other introducing platform, *he* must press the button, it being a case of "first come, first served." Whoever presses the button first secures the companion he or she desires.



At the right is a general lay-out picture showing the construction of the tracks, and the various separating features on the course. If one companion does not please the other, pressing a button in the car flashes a lamp on the selective switchboard, the operator of which automatically switches the car into one of the separating systems.

During the rather unconventional introducing ceremony, and the subsequent passage to one of the "paradise-apple" domes, the young lady must determine the qualifications of the gentleman to whom she has been so informally introduced. Perhaps a lovelight will be shining in each of their eyes before they reach the cozy passage in the circular dome-like structure called a "paradise apple," or on the other hand, she may find that he does not possess any of the qualifications she expects to find in a gentleman. She will then press another button, indicating to the operator that a separation from her companion is desired. When they reach the dome, his car is suddenly shunted off on a side track, but she keeps on going ahead. Reaching the end of his little passage on one of the legs of a V-shaped detour, his car backs away and joins the track, thereafter continuing over the original course, but in a backward direction. This indicates to all of the patrons of the rail

(*Cont. on page* 906)



1922 by Science and Invention

A Yankee genius has proposed a new scheme for illuminating Niagara Falls at night, utilizing for the purpose submerged searchlights fitted with color filters, the light rays being reflected down through the falling waters, on the principle we used to study in our physics books. The manner in which these light rays are reflected back and forth down the stream of water, is indicated by the dotted lines in the upper left-hand detail drawing. The lamps are held submerged by means of the device shown at right. The magnetic release permits the device to float the instant the bulb is damaged or burnt out.

Submerged Spotlights for Niagara

ONE of the proudest sights of which America boasts, and the name of which has resounded from ocean to ocean, all over the civilized world, and from the snow-covered fields of the northern to those of the southern hemisphere, is Niagara Falls. Various attempts have been made, by illuminating the falls at night, to beautify the natural gigantic masses of water which rush over the precipitous bed of rock, dashing themselves into a foam and rushing onward to join the waters of the Atlantic. Up to the present time flood lights have been employed for this purpose, the waters of the Niagara river turning immense turbo-generators, part of whose power was used to light up banks of lamps, and illuminate the scenery at night. These flood lights cause objects, such as trees and banks, to stand out brilliantly illuminated against the dark sky, giving them a ghastly appearance, and the falls, although taking on a silvery sheen, lose their effectiveness.

A New York genius has made a suggestion for illuminating these falls which should be more effective in conveying to the visitor their splendor. Large incandescent lamps for this purpose are mounted in globe-like metal containers, which are provided with vanes, so as to keep them headed in the right direction into the stream. These globular casings are made similar to depth bombs, having a small water ballast compartment and an anchor, together with the proper chains for securing them to that anchor, and a sinking arrangement which will cause the electric light containers to be drawn below the surface of the water. A cable is stretched across the falls, from which the leads to the lights below the surface of the water depend, or a sunken cable may be employed. We thus have a whole series of projectors located below the surface of the waters of the falls, so placed that their beams of lights will be projected directly through the rushing torrent. Each individual projector will be colored differently, and if properly placed there would be a possibility of securing, if not a total, at

(*Continued on page* 909)

Future Wars and the Long Range Gun

By NOEL DEISCH

AMONG all the murderous contrivances that were newly born or developed to a new potency during the European war, none carries more appalling possibilities for desolating effect than the supercannon or long-range gun. We refer of course to the diabolical "Bertha" that lay hid in the woods of St. Gobain, and day after day, through those sunshiny summer months of 1918, dropped down on Paris with deliberate German regularity steel shells that exploded in markets and homes and churches without discrimination, and in a twinkling converted them into heaps of ruins.

The "Bertha" was an unprecedented and a sensational accomplishment. No one has ever doubted that; but its notoriety as an accomplishment will forever be tainted by mortifying memories of its ghastly effect. Over against every picture featuring the phenomenal giant of ordnance we can not help setting one of its cruelly mutilated victims, many of whom were inoffensive civilians.

Not many people are worrying about long-range guns nowadays, nor is it probable that they ever shall until the time again comes for them to aim them, or to be aimed *at* by them. Yet not a few of us feel a little justifiable curiosity, and still fewer of us a little justifiable apprehension: we want to know what we may expect our experts of the War Department to produce.

Everybody knows that the harder you throw a stone the farther it will go, but not everybody knows that under conditions it will go more than twice as far when you throw it at twice the speed, or that, in other words, the range increases more rapidly than the velocity in vacuo and at a definite range of elevations. This fact is more strikingly true at the higher velocities, and as we shall see, particularly when the velocities become of the order of those produced by a supercannon.

Take a cannon whose projectile has a velocity of 2,000 feet per second. It would shoot 24 miles if the conditions were mathematically ideal. But a gun giving a velocity of 4,000 feet per second, just twice as great, would reach 91 miles or nearly 4 times as far. If the velocity of the projectile be pushed much beyond this figure we will get a rather surprising result. Only 1,000 feet per second added to our previous 4,000 feet, that is, 5,000 feet or nearly a mile in all, will make the projectile go 147 miles. Not to become tedious it may be stated that it can be proved mathematically that a bullet with a velocity of 25,000 feet per second, or a little under five miles, would go all the way around the earth if it traveled above the atmosphere, and that hence, if aimed correctly, it could be made to fall on any part of this earth that might be desired. In fact, if the shot were fired at a velocity of seven miles per second it could be made to go as far as the moon, or to any other body out in the sky, and never come back at all,—but that is another story. We are interested just now in projectiles that do come back, and in the fact that anybody who had a gun that would discharge them with a velocity only a little over five times greater than that which has already been attained by artillerists, would be in a position to drop a shell on any part of this little globe of ours that it might be his good pleasure to choose.

There are of course very considerable difficulties in the way of transferring a gun of this kind from an engineer's working drawings, which rest on a basis of pure theory, to a practical structure of steel, resting on a basis of reinforced concrete. Yet these difficulties have not appeared in any way insurmountable to some artillerists,—to Major J. Maitland-Addison, for instance, who, in a long article in the *Journal of the Royal Artillery*, published during the war, spoke very hopefully of the future of the Bertha.

(*Continued on page* 894)

Fig. 3. Cross-section of the supercannon that will fire around the earth. The barrel is 500 feet long, although its bore would probably be only about 12 inches. A very large powder chamber is necessary to hold the enormous charge of powder required. The moveable framework that supports the barrel is counter-balanced at the lower end by means of a heavy weight, which makes the tower stable at all angles of inclination. The rotating platform is supported on oil under heavy pressure, so that the whole gun may be easily moved, for training in azimuth.

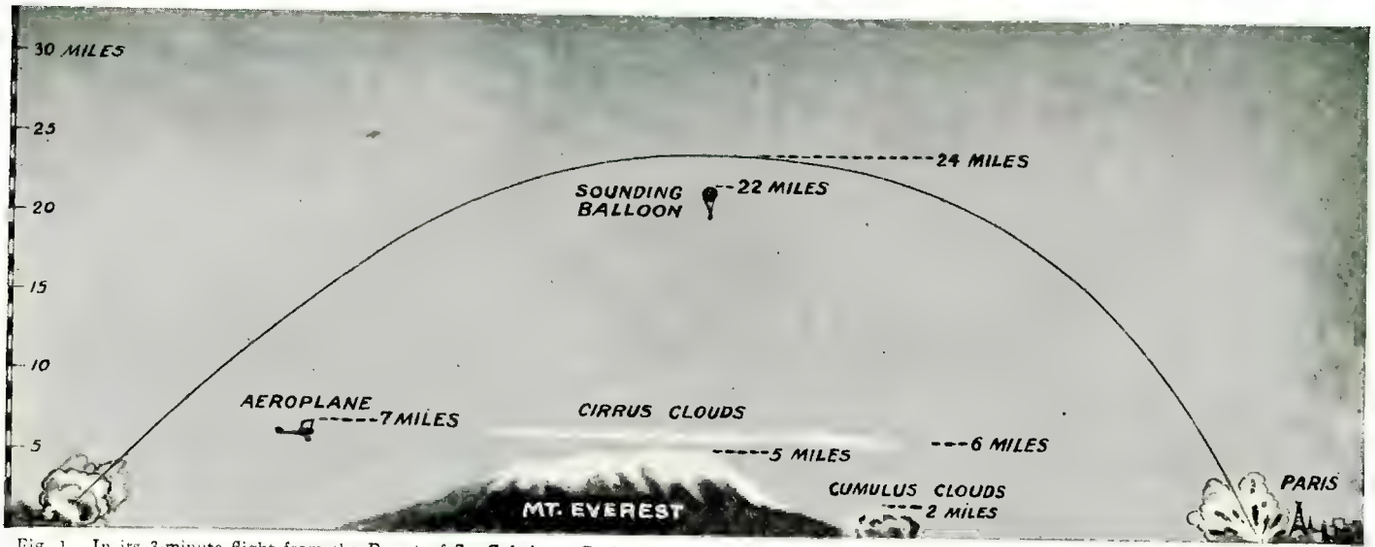
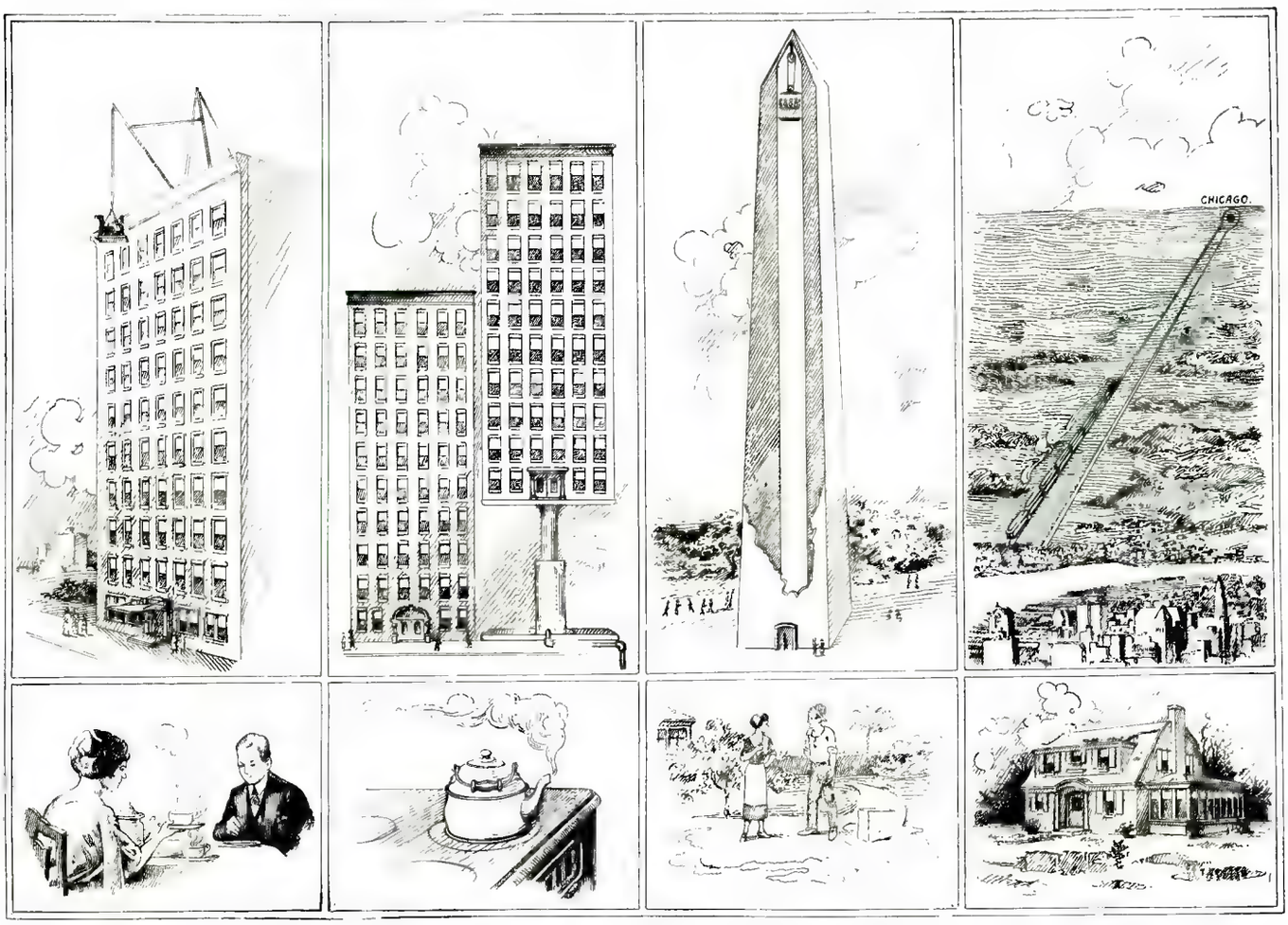


Fig. 1. In its 3-minute flight from the Forest of St. Gobain to Paris, 76 miles distant, the shell fired by the "Big Bertha" rose 24 miles into the air, far above the highest mountains, the highest clouds, and the highest flights made by airplanes or balloons, whether manned or free.



The energy in two cups of coffee, steaming hot, is sufficient to raise a kitchen range and coal to the top of a ten-story building.

A ten-story building could be lifted fifty feet into the air, by the energy required to boil away a kettle of water.

Fifty pounds of ice melted away could lift a carload of people to the top of the Washington Monument, if the energy required could be completely converted

The energy required to melt six inches of snow on a lawn 5,000 feet square could drive a seven car train to Chicago and back at fifty miles an hour.

An Invisible Giant

By J. C. PACKARD

SEVENTY-NINE years ago, in 1843, to be more exact, a young Englishman, James Prescott Joule by name, learned that water can be heated by stirring it and that the more it is stirred the hotter it gets.

Keenly alive to the significance of this simple fact, he set about to determine the exact relation existing between the work done in stirring the water and the amount of heat developed. Iron weights, suspended over a system of pulleys, were used to furnish the power and the water was stirred by a sort of a paddle wheel run by the falling weights. With such apparatus Joule discovered that a pound weight descending 778 feet exerted enough energy to raise the temperature of a pound of water 1 degree Fahrenheit.

Thinking of a British thermal unit (B.t.u.) as the amount of heat required to raise the temperature of a pound of water through one degree Fahrenheit, and a foot-pound (ft. lb.) as the amount of energy expended in raising a pound weight through a distance of one foot, we may say, in modern parlance, that:

1 B.t.u = 778 ft. lb.

Now, herein lies a marvelous principle! If we can figure the amount of energy required to melt ice, to boil water, and to make steam or water vapor, we may be able to get a new line on the invisible giant, Heat, and to discover how much work he is performing daily, without fuss or worry, in our kitchens and about our home grounds.

Let's see. Two more facts and we are ready. To change one pound of ice into water at 32° F. requires 147 B.t.u. To change one pound of water at 212° F. into steam or water vapor calls for 960 B.t.u.

Then, 1. "Two cups of coffee, steaming hot," call for: a pint of water (1lb.) to be raised from about 50° to 212°F.; 162 B.t.u., 126,000 ft. lbs. of energy. Energy enough to lift the whole outfit, coal, range and all, to the top of a ten-story building.

2. "The tea-kettle has boiled away": two quarts of water changed into water vapor and poured into the atmosphere, while a friend was being entertained at the breakfast table: 3840 B.t.u: 2,980,000 ft. lbs. Energy enough to lift the whole house, bodily, fifty feet, straight up into the air.

3. "The ice is all melted": fifty pounds of ice changed into water in the refrigerator: 7350 B.t.u.: 5,718,100 ft. lbs. Energy enough to lift a carload of thirty men to the top of the Washington Monument.

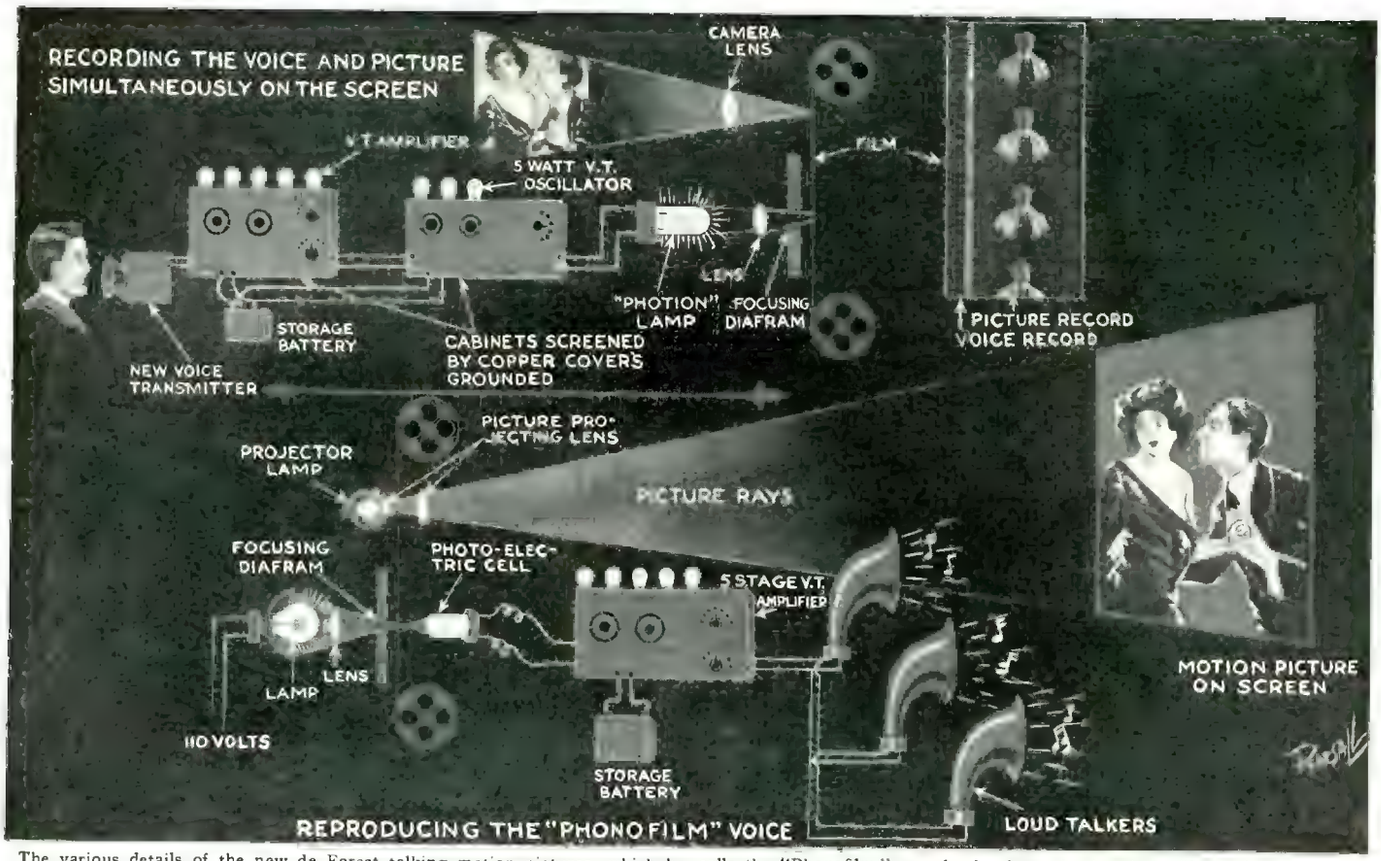
4. "The snow has all disappeared": six inches of snow and ice melted away on the lawn (5,000 sq. ft.): 25 tons: 7,350,000 B.t.u.: 5,718,300,000 ft. lb. Energy enough to run a seven-passenger car from New York to Chicago and back at the rate of fifty miles an hour.

What a giant Heat is! How quietly he works. If we could harness him completely what couldn't we accomplish? He is already hard at work for us in our furnaces, in our locomotives, and in our automobiles. But we are using only the merest fraction of his vast energy. Some day we may be able to use a greater proportion and waste less.

Install Slug Detectors to Foil Subway Cheaters

No longer will the New York subway find pounds of iron scraps, brass hat checks, pfennigs and hammered-out pennies in a day's turnstile receipts, as the company is installing a device known as a bull's-eye slug detector on the automatic turnstiles.

Since the inception of the automatic turnstiles the company has been trying to combat the problem which arose when misplaced genius discovered that a nickel wasn't the only thing that would provide an open sesame to the train platform. The new device has been described by engineers of the Transit Commission as a pocket or box in the turnstile containing an electric light with a bull's eye lens in front, so that a vastly magnified image of the nickel—or the junk—is projected through the glass and is readily visible several feet away. It will thus be easy for the station agent or an inspector to detect a cheater.

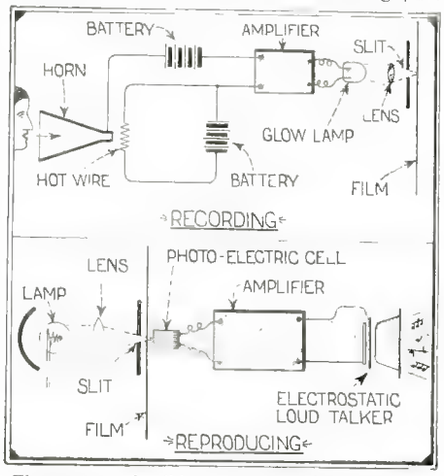


The various details of the new de Forest talking motion pictures, which he calls the "Phonofilm," are clearly shown in the above illustration. As will be seen, the pictures of the actors are photographed on the same film with the voice. The voice record appears as a series of light and dark bands beside the picture record. A strong light thrown through the film voice record falls on a photo-electric cell, as shown in the lower diagram, which causes variations in the amplified current supplied to the loud-talkers distributed about the motion picture theatre.

Movies That Talk

THE DE FOREST TALKING MOVIE

IN a recent interview with Dr. de Forest, he told the editors several interesting things about his latest venture in the realm of applied science, namely, *talking movies*. We have published several articles describing talking motion pictures, and herewith we publish the description of three other similar inventions, which are interesting for comparison purposes. Dr de Forest believes that he has a system of talking movies superior to those devices so far invented, and for several reasons. One of the principal reasons lies in the fact, as pointed out by the Doctor—no moving part having inertia to overcome and thus cause lagging in the circuit, is involved from the time the voice waves strike the mouthpiece of the transmitter or recorder, up until the time when the fluctuating electric currents corresponding to the undulations of the voice, pass into the loud-speaking telephone or telephones, placed in the auditorium. Think what this means! Inertia-less electric currents and light rays coupled with photography and radio as well as audio-frequency currents, have solved the problem under the clever directorship of Dr. de Forest.

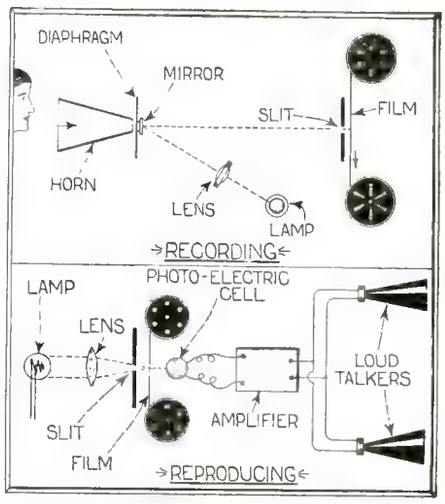


The system of talking movies evolved by three German inventors and commonly known as the Vogt System, is shown above. Here the voice air waves cause changes in the ionized field about a hot wire at the end of the horn, which causes variations in the glow lamp before the recording film. A photo-electric cell and amplifier interpret the photographic voice record, by the aid of an electrostatic loud-talker.

Referring to the diagram herewith, we see how the speaker's voice is picked up by the recording mouthpiece, and the inventor cannot disclose details of this device just yet for patent reasons, but he states that it embodies a new principle in electro-physics, and that no moving parts are involved in its construction and action. The modulating device causes the electric current passing through it to undulate and mold itself, so to speak, to the voice or sound waves coming from the speaker's mouth, and the electric current fluctuations are amplified in a well-known manner by a five or higher stage audion amplifier. When these currents have been increased several thousand fold in this manner, they are passed on to a five-watt radio frequency vacuum tube oscillator, as shown in the figure. From here the voice waves in the form of radio-frequency oscillations are impressed upon a new lamp-like device perfected by the inventor, and called the *Photion*.

"For patent reasons, details regarding the Photion cannot be disclosed just yet," said Dr. de Forest, "but in general the device consists of a clear glass tube or bulb filled with a certain gas, the brilliancy of which is caused to change in accordance with the voice fluctuations." While the inventor found in his earlier experiments that he could make very good voice records on the picture film without a lens, he now invariably uses a lens placed between the Photion tube and a specially built focussing diaphragm, having a slit shaped opening. This diaphragm slit is placed close to and in front of the film.

The idea of the voice recording scheme is eventually to have this apparatus made very compact, and to have the Photion tube mounted inside the motion-picture camera, so that the voice record will be made on the

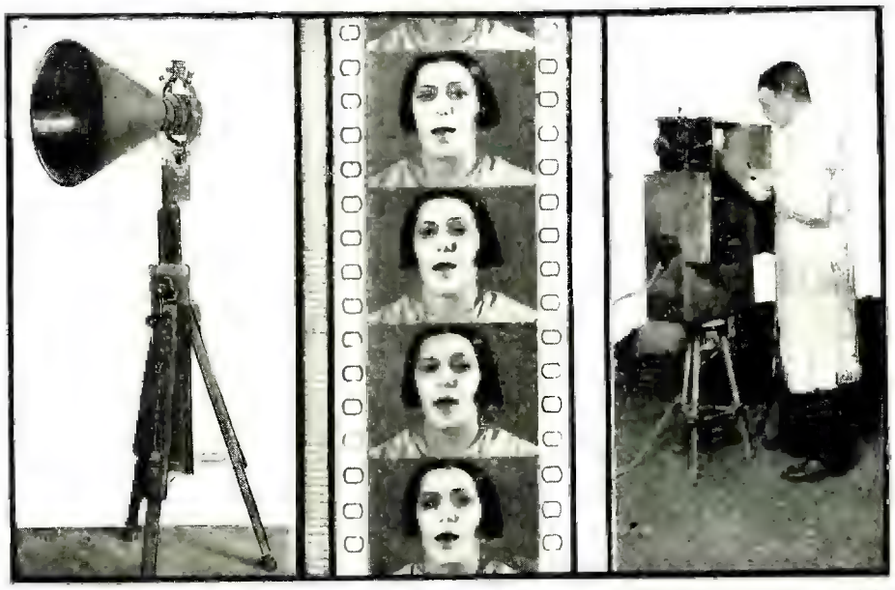


The Hoxie talking movie system is shown in its general form in the diagram above. A small mirror mounted on the diaphragm of the recording horn varies a beam of light focused on to it through a lens; the photographic record of the voice on the film is interpreted by a photo-electric cell, amplifier and loud-talkers, as shown in the lower part of the diagram.

film simultaneously with the record. It will be seen from the accompanying illustration, that the voice record occupies only about one-tenth the space normally occupied by the picture. The bands or striations along the film and representing the voice record are continuous, looking at the film crosswise, and not peaked, as in some other talking movie records of this nature which have been made previously. The voice record and the picture record are staggered a few inches, so that the former is not subjected to the jerking of the film at the point where it passes through the intermittent motion mechanism. This was rather a hard problem to solve satisfactorily, but it seems to be the best method, and is giving very excellent results in the experiments now being conducted by Dr. de Forest, and he hopes to be able to demonstrate his talking movie in a New York theatre in a couple of months. It is interesting to note that a potential as high as 5,000 to 7,000 volts is applied to the Photion tube when the voice modulated, radio-frequency currents pass into it.

The reproducing action of the de Forest talking movie takes place as follows: A powerful light and reflector together with a lens, serves to focus a beam of light through an adjustable slit, upon the positive film in the projector, which contains the voice record, as well as the picture record side by side. The film is of standard width, and it passes down through the projector without any intermittent motion at the point where the photo-electric cell and light ray device are situated, as this would interfere with the smooth reproduction of the voice, and the succeeding light and dark bands corresponding to the voice waves, cause the ray of light to be constantly changed in strength as it falls upon the photo-electric cell, and the changes in the cell's resistance cause corresponding fluctuations in the current impressed on the vacuum tube of the five or higher stage V. T. amplifier shown. The output circuit from this amplifier is connected to one or more loud-talkers of a well-known type.

Dr. de Forest's experiments in recording the voice necessitated several changes in his laboratory, one of the most interesting being that he had to cover the walls, ceiling and floor with felt, to eliminate all echoes from the voice. It is most uncanny when one speaks in this silent room, as the voice sounds so dead. When talking movies come into their own, as they undoubtedly will in the next few years, the details involved in photographing the actors and scenes will be quite different from those of the present time. For one thing, the megaphone and its accompanying well-known shouting director or stage manager, will be no more. The director, in talking movies, will have to employ the sign language, or else use electric flashlight signals. Another scheme might well be to have a drum provided with a number of signs, such as "stop," "start," "talk louder," etc., which could be spun around and stopped electrically whenever the director pushed the proper buttons. Another peculiar problem met with in producing talking movies is that of properly proportioning the strength of the voice for actors standing at various distances from the camera. A man standing thirty feet away in the center will naturally not be expected to have the same strength of voice as an actor standing in the immediate foreground; and when we come to close-ups, good-night! By the natural mathematical law, a close-up of Mary Pickford with her eyes about two feet in diameter on the theatre screen, would call for a voice sounding like Niagara's roar.



The Vogt System of talking movies is shown in part by the photographs above. The photo at left shows recorder with hot wire element used in place of microphone; center picture shows film with pictures of singer, and voice record on the extreme left-hand edge of the film; the right-hand picture shows the projector.

C. A. HOXIE, RADIO EXPERT, DEVISES "TALKING MOVIES"

An ingenious apparatus for recording sounds upon a photographic film, so that the sound may afterward be reproduced in ordinary telephones, loud speakers, etc., invented by C. A. Hoxie, has been developed in the General Engineering Laboratory of the General Electric Company, and brings immeasurably nearer the day of the practical talking movie.

Here is a new American "talking movie" machine developed by Mr. Hoxie of the General Electric Company, of Schenectady, N. Y. This machine employs a vibrating mirror mounted on the diaphragm before the horn, into which the speaker talks. A beam of light passes through the lens shown, on to the diaphragm-mirror element, and thence on to the film passing before it.

It also means a boon to radio broadcasting studios. From a central studio, say in New York City, the world's greatest artists can perform before this machine which produces the film. Copies of this film may then be made and sent to other stations and reproduced with exactly the same clearness as if the artist were himself present.

It makes possible the talking movie, for on a film of the normal width, can be the picture of the voice of the actor, as well as the photographic record of his action, both voice and action absolutely synchronized because they are part of the same film.

C. A. Hoxie is the man credited with the invention of the device which is called the *Pallo-Photo-Phone*.

The record is made by causing the sound waves to produce vibrations of an exceedingly minute and very delicate mirror. A beam of light reflected by this mirror strikes a photographic film which is kept in continuous motion. The film when developed shows a band of white with delicate markings on the edges which correspond to the sound which has been reproduced. On account of the exceedingly small size of the mirror, its low inertia, etc., it is possible by this means to produce a sound record which includes the very delicate "overtones" which give quality to speech and musical sounds. This has not been so successfully accomplished by any other method of recording sound waves.

The reproduction of the sound from the film is accomplished by moving the film in front of an exceedingly delicate electrical device which produces an electromotive force which varies with the amount of light which falls upon it. In the past attempts have been made to produce these results by means of selenium cells, but a selenium cell, though it responds to the changes in the amount of light which it receives, does not respond with sufficient promptness to produce good results; there is a sluggishness in the response which seriously interferes with the quality of sound which is produced.

By an ingenious combination of vacuum tubes, there has been produced an apparatus which responds to variations in the light falling on it with a speed which is so high that it can only be compared with the speed of light itself, or with the speed of propagation of wireless waves in space. Therefore, when this film is moved continuously in front of such a device, the apparatus produces an electric current which corresponds very accurately to the original sound wave. This electric current may be used to actuate a telephone or loud speaker. It was actually used recently to operate the radio transmitting station WGY of the General Electric Company. The well-known voice

(*Continued on page* 898)

Motion Picture Phonograph

A YANKEE inventor, Harry N. Butz, of Chicago, has applied for a patent on an extremely clever motion picture phonograph, intended for use in the home or elsewhere. The accompanying illustrations will help to make clear how Mr. Butz combines not only moving pictures and music in one cabinet, but also how he has provided a brand new idea in phonograph records, in that he advocates the use of a single transparent record made from celluloid or other suitable material, which shall contain at once not only a progressive spiral of miniature pictures on one surface, but on the opposite surface engraved or stamped shall appear the music record grooves. At first thought it would seem that a beam of light passed through the record, so as to flash the picture on the screen by means of suitable lenses and oscillating mirrors as the diagram shows, would project undesirable shadows or bands on the screen picture, due to the music grooves on the record, and through which the light is to pass before it produces the picture. In view of the fact that the record would be fully transparent, the music grooves would not interfere, however.

As will be seen by studying the illustrations, the inventor has provided a clever arrangement of the music tone-arm, and a second moving arm carrying a lens and powerful light with reflector, so that as the record plays, the tone arm, thanks to a second ball and socket joint, it moves inward as the tone arm and sound box rotate, so as to permit the light and lens arm to move inward simultaneously, in order to follow the spiral string of pictures on the record. The tone arm is fitted with a knife and slot joint, so that it can be instantly removed from the center driving shaft in order to replace the record with a new one. The lamp arm is also provided with a ball and socket joint, so that it can be moved out of the way in order to facilitate the removal and replacement of records.

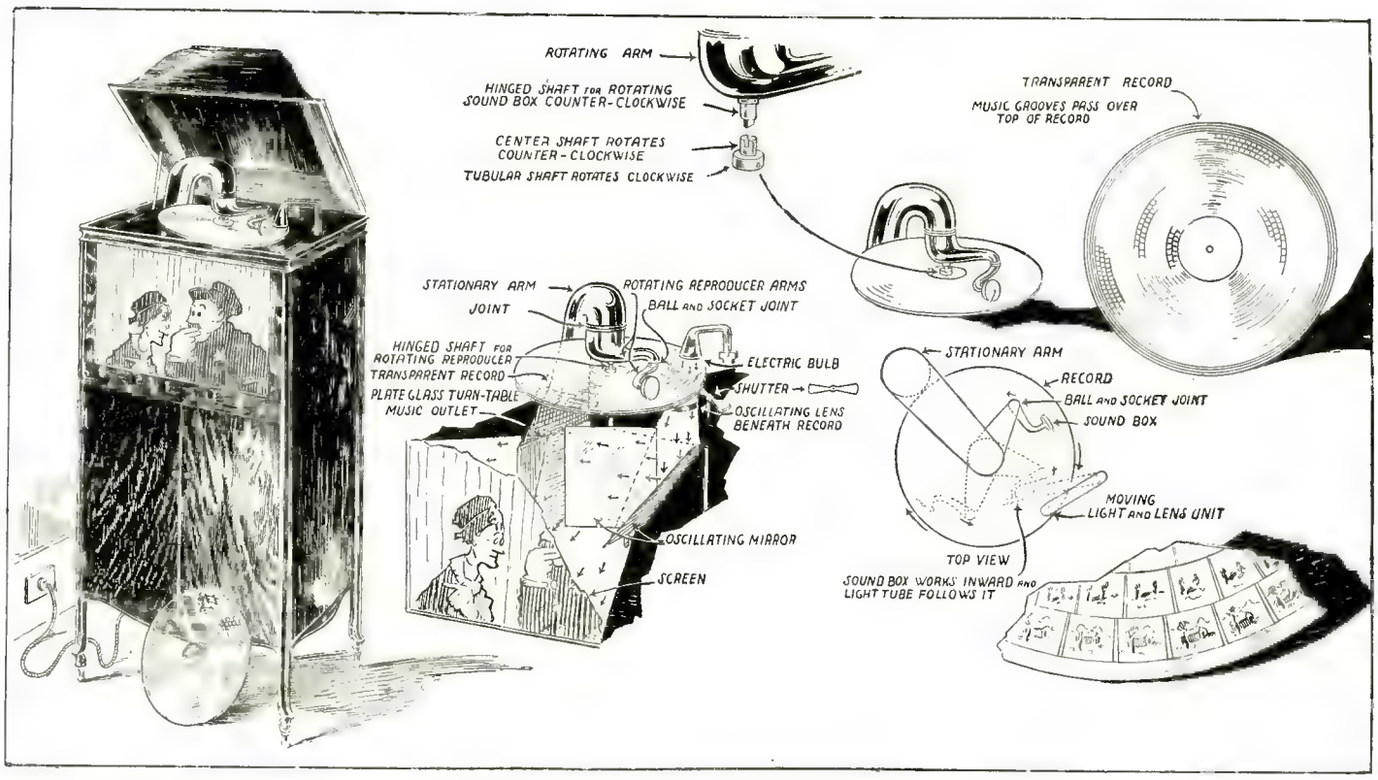
The glass turntable and celluloid record are driven through a double shaft drive, so that the hollow shaft rotating the turn table revolves clockwise 6 2/3 revolutions per minute, while the inner solid shaft is geared to drive the sound box and tone arm around counter-clockwise at 53 1/3 turns per minute. Thus the relative speed of the sound box needle around the record is made equivalent to sixty turns per minute.

As the perspective view of the turn table, tone arm, mirrors, etc., shows, the beam of light from the lamp and lens arm which moves over the top of the record, passes down through the pictures on the record and glass turn table as it rotates; thence through a revolving cut-off shutter, and a second lens, which moves in synchronism with the upper lens, this last lens and the shutter being placed under the turn table. Following the rays of light on downward, we find that they carry the picture image down to an oscillating mirror placed at an angle of 45°, and the picture is then reflected on a second oscillating mirror, and from this on to the screen, mounted in the phonograph cabinet, where the opening of the sound chamber is usually found. This screen may be of cloth, when the sound from the tone arm and amplifying chamber can hence pass through it; or if the screen is of glasss, suitable openings for the sound can be arranged for in some other place.

The purpose of the revolving shutter driven by suitable gearing from the electric or spring motor which drives the turn table and other parts of the apparatus, is to cut off the light in the interval between two pictures and prevent the border line in the pictures flashing across the screen. The oscillating motion of the mirrors compensates for the effect usually obtained in the orthodox movie projector, where an intermittent motion device stops each picture for a sixteenth of a second before the lens. The oscillating motion of the mirrors is taken care of by suitable gears.

In making the records for this movie phonograph after the plans formulated by Mr. Butz, the inventor, several methods may be used for imprinting the pictures on the record. The record may, for example, be coated with a sensitized emulsion, so that the pictures can be photographed upon it, and the record then developed and fixed. The inventor provides another idea which is somewhat simple to carry out, and also involves the commendable feature of having the pictures on one record and the voice record on another disc, two turn tables being used, one alongside the other. The tone arm is driven over the first turn table on the voice record, while the light projector arm, lens and shutter system, is propelled across the second turn table containing the picture record.

The data as given by the inventor for a 12-inch combination and picture record, prove interesting. On a 12-inch record, he finds that he can place 180 turns of music grooves; 2,880 individual pictures, each of the size 9/64 inches by 3/16 inches, or in other words, twenty turns in the picture spiral. The size of the picture on the screen he proposes to be 9 inches by 12 inches, giving a magnification of sixty-four diameters. The number of pictures projected per second is sixteen.



One of the cleverest motion picture phonographs for the parlor that we have seen in some time, is that here proposed by Harry N. Butz, who has applied for a patent on it. As will be seen the inventor utilizes transparent records, on one face of which are the pictures running around in spiral formation, and on the upper surface we find the voice record grooves. A traveling electric light arm and lens system operates in synchronism with the revolving tone arm, as the diagrams show, so that as the sound box travels inward on the record, the light arm and lenses also move inward, so that eventually all of the pictures in the continuous spiral are flashed on the screen in the front of the cabinet.

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A large bold sign printed in foaming letters, appearing on the surface of the water of a river or lake, is an awe-inspiring sight, and although at first such an installation seems impossible, it is a very simple effect, easily produced. Compressed air is the agent and submerged perforated pipes constitute the letter forming devices.

Advertising Signs On Water's Surface

WE were motoring along the banks of a river enjoying the scenery of the surrounding country, when my companion suddenly grasped my arm almost tearing it away from the steering wheel exclaiming, "Look at the river." I glanced in the direction indicated, and there in the center of the stream, made in white foam were the gigantic letters of an advertising sign. Even as I watched, these letters disappeared. It was the most wonderful spectacle I had ever witnessed. We proceeded to move away slowly, but before we could pick up any speed, we again saw the foam letters, which must have been at least 8 feet long appearing on the surface of the water. A steamer passed across the letters, disturbing for the moment their shape, but they reappeared again, and then disappeared. We continued our trip, and coming down in the evening saw the whole water ablaze, the same sign appearing on the surface. This time it was made in fiery letters, the flames burning on the surface of the water. What surprised us the most was the fact that although the wind and current at this time were rather strong, the letters maintained their position. Being of inquisitive turns of mind, we decided to investigate. The next day having procured a boat and rowed to the spot where these letters were being formed, we found that although the water here was relatively clear, we could see nothing; the foam was lashed up by air bubbles, but we could not determine the source of these bubbles. We eventually were put in touch with the engineer of the scheme through the advertiser; this is what we learned.

A large frame made of steel tubing has mounted upon it and connected to the tubing gigantic hollow letters, the shells of which letters are drilled with myriads of minute holes. This frame has two buoyant members at either end which tend to make it rise and float, but it is being retained to its present position by means of anchoring arrangements. A tiny buoy at this spot actuates a release for permitting the frame to ascend to the surface of the water, and thus allow for the changing of the advertisement. By means of a relatively short section of flexible hose and connected to other pipes, the frame communicates with a compressed air blower located on the shore, which intermittently forces air into the letter forming pipes. The air escaping from the minute holes, produces letters in water lashing it up to a foam. These bubbles further serve to raise the surface of the water at that particular point, so that they may be observed at greater distances, and in no way is the scenery on either side of the river interfered with by objectionable signs, nor is navigation on the river impaired. For forming the luminous night signals, acetylene gas evolved by the action of water upon calcium carbide, is permitted to bubble through the regular piping system, and intermittently phosphine is introduced. Phosphine on coming in contact with the air and the acetylene gas causes the latter gas to ignite, burning on the surface of the water. Even when the stream is moving rather swiftly, and the wind blowing strongly, the letters maintain their relative positions. This device is the invention of Helmut Junghams and Fritz Glogauer, and promises to become a very wonderful and unique advertising feature.

The pipes are painted a dull gray, completely camouflaging them when at a depth of more than three feet. The special relation of the letters as well as their relative size depends on the width of the river or stream, the speed at which it flows and the depth to which the signs must be submerged.

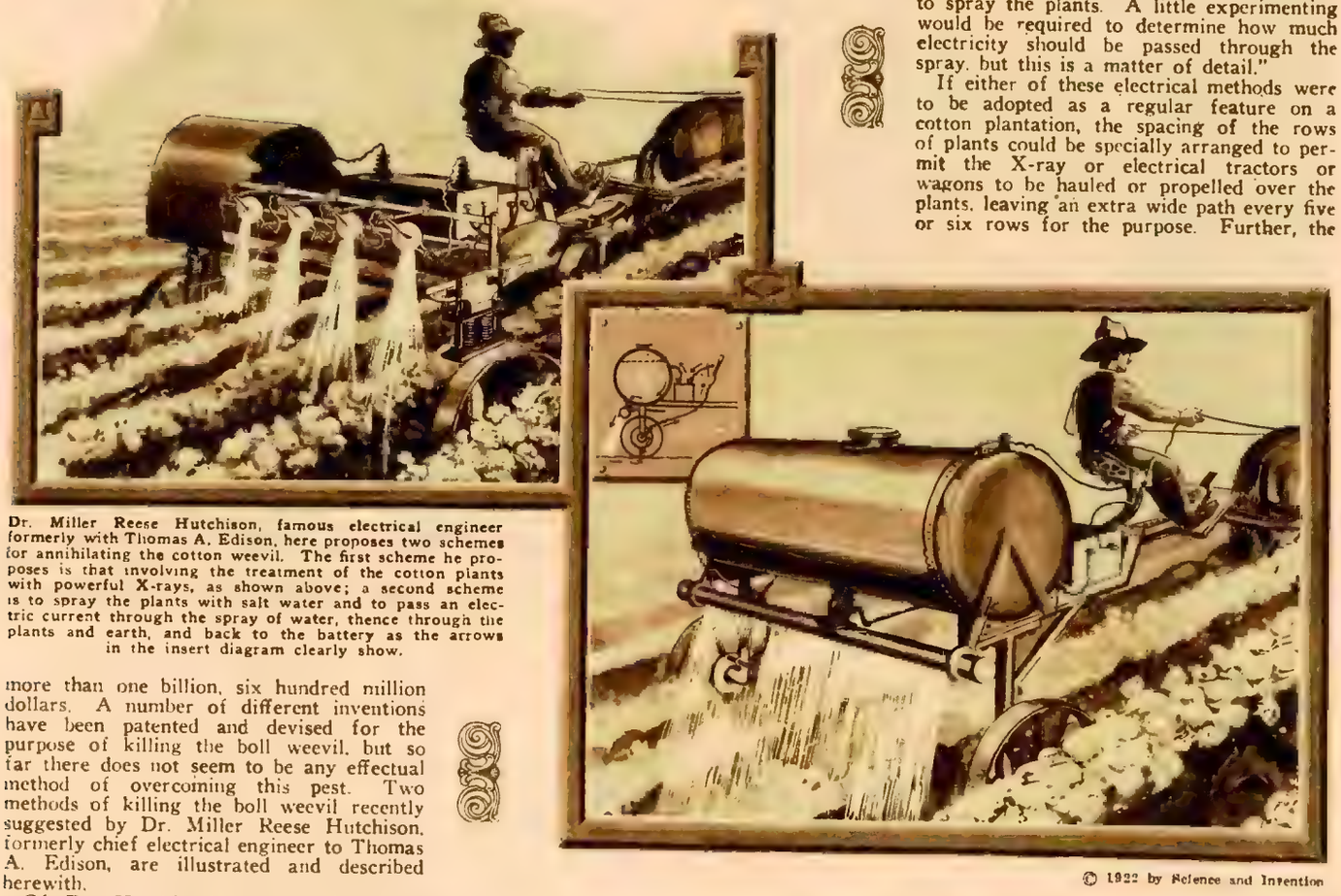
Sees New Flight Era In Huge Oil Engine

A promise of astonishing developments in cheap transport in air is held out by a new oil engine for flying machines evolved secretly after long research by a famous armament firm in conjunction with the British Air Ministry. The engine will soon undergo tests in the air. It is said to be no heavier than a gasoline airplane engine and to burn crude oil, a fuel whose cost is not more than half that of first grade airplane gasoline.

The engine is a 6 cylinder 750 H.P. monster.

X-Rays and Electric Current To Kill Cotton Weevil

THE cotton growers of the Southern States are up in arms, and ready to spend valuable time and money in an effort to annihilate the ravages of the devastating boll weevil, sometimes called *cotton weevil*, which according to an estimate made by Dr. L. O. Howard, Chief of the Government Bureau of Entomology, caused a crop loss in five years of more than one billion, six hundred million dollars. A number of different inventions have been patented and devised for the purpose of killing the boll weevil, but so far there does not seem to be any effectual method of overcoming this pest. Two methods of killing the boll weevil recently suggested by Dr. Miller Reese Hutchison, formerly chief electrical engineer to Thomas A. Edison, are illustrated and described herewith.



Dr. Miller Reese Hutchison, famous electrical engineer formerly with Thomas A. Edison, here proposes two schemes for annihilating the cotton weevil. The first scheme he proposes is that involving the treatment of the cotton plants with powerful X-rays, as shown above; a second scheme is to spray the plants with salt water and to pass an electric current through the spray of water, thence through the plants and earth, and back to the battery as the arrows in the insert diagram clearly show.

Of Dr. Hutchison's suggestions one is the treatment of the plants with powerful X-rays by drawing a cart or wagon over several rows of the plants simultaneously, this wagon being fitted with X-ray tubes and the necessary high voltage exciting apparatus, as shown in one of the pictures; while the second suggestion here illustrated involves passing a low voltage electrical current from a storage battery or dynamo through the plants, via streams of dilute salt water, sprayed over them from a suitable wagon or tractor, as the other picture shows. Regarding these two methods, Dr. Hutchison stated:

"It is known that sterility can be induced in the male and female of the entire animal kingdom and in all kinds of eggs by the intelligent and local application of X-rays.

"The boll, and in fact all parts of the cotton plant, are transparent to X-rays. Therefore, why could not the eggs laid by the moth and the weevil hatched from the egg be made sterile by the application of X-rays from a battery of tubes mounted on a high-wheeled vehicle straddling several rows of plants, and drawn along by a properly constructed and equipped vehicle?

"Heavy sheets of lead, properly bent and placed over the tubes, would shield the operator, concentrating the X-rays down and producing sterility in every egg and weevil on the plants.

"Some genius has discovered that adult weevils are killed by an electrical current having a potential of six volts. If such is the case, it would be a very simple matter to spray the plants. A little experimenting would be required to determine how much electricity should be passed through the spray, but this is a matter of detail."

If either of these electrical methods were to be adopted as a regular feature on a cotton plantation, the spacing of the rows of plants could be specially arranged to permit the X-ray or electrical tractors or wagons to be hauled or propelled over the plants, leaving an extra wide path every five or six rows for the purpose. Further, the current for propelling the specially built tractor, equipped with extra large wheels, could be taken from overhead trolley wires and poles similar to those used for trolley cars. On some of the German electrified farms tractors and other farm machines are propelled over the fields in this way.

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Oyster Changes Its Sex Three Times

Although an oyster's existence is usually a shut-in one, yet there is one oyster, hailing from the River Blackwater, near Colchester, England, who has seen much of life.

He has changed his sex three times in the past twelve months.

This fact is vouched for by Dr. J. H. Orton, a well-known scientist of West Mersea. He found a male oyster in June, 1921, and kept it, even going so far as to give it the pet name of Oliver, being, of course, unaware of the curious twist in the creature's nature.

Young Oliver, according to a letter written by Dr. Orton to the British Medical Journal, was a happy, contented, affectionate little bivalve until July 3, 1922. On that day Dr. Orton found that Oliver had presented him with thousands of young oyster children.

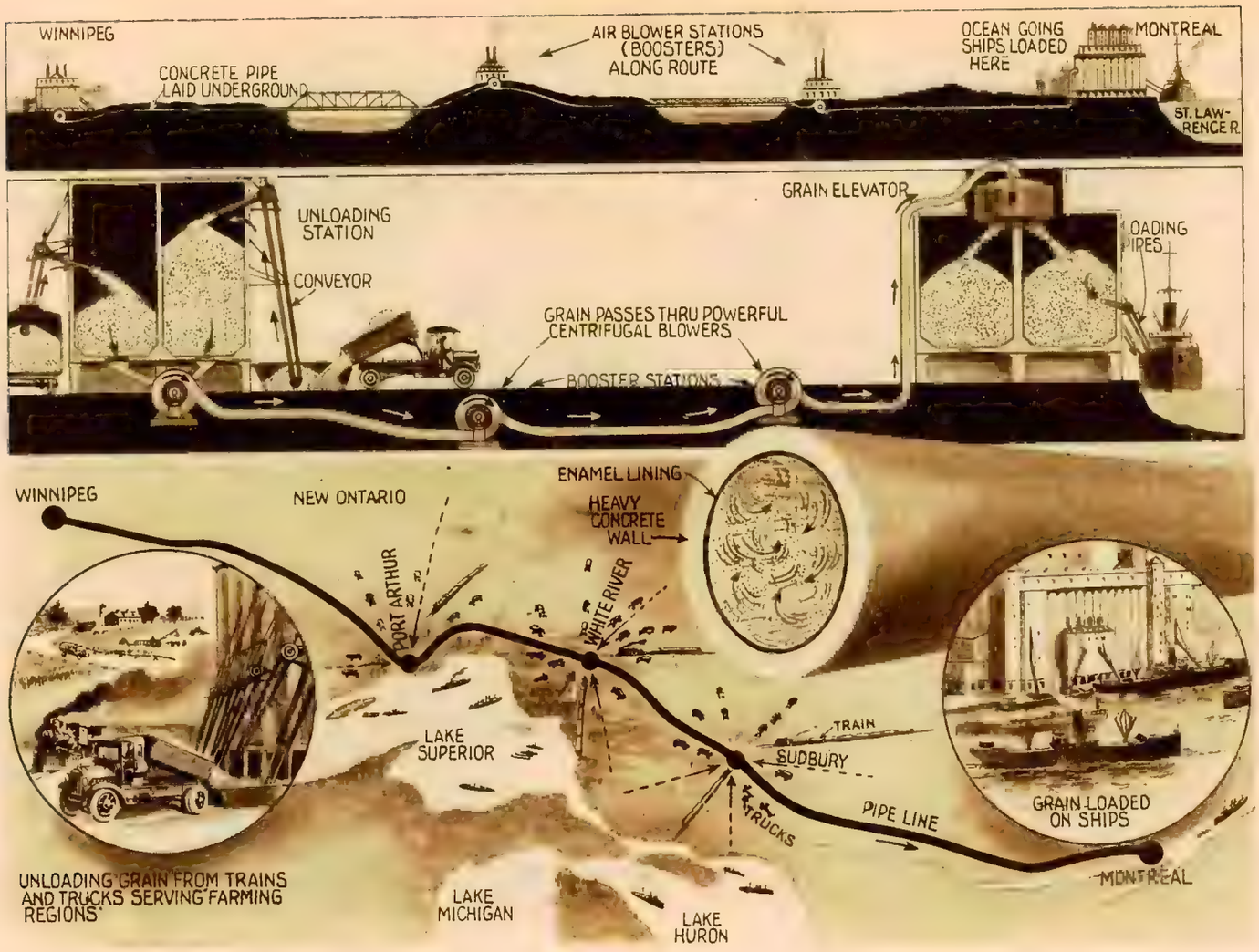
Oliver's name was immediately changed to Olivette, but a fortnight later it was found that he or she had again joined the male sex. So that within twelve months Oliver, or Olivette, according as he or she may be today, has had three experiences of sex.

Oliver is now taking a vacation in the Marine Biological Laboratory at Plymouth, where numbers of scientific men sit at his feet, and in order to avoid confusion, he is now commonly addressed as "Olly."

Dr. Orton thinks that the sex change is due to changes in the environment and that Olly can please himself whether he will be a male or a female. He hopes to learn a lot more yet about the oyster.

But Olly sits tight and says nothing.

Wherefore all the investigations and scientific researches by men of worldly fame who attempt by means of X-rays, diet, freezing, and other natural and unnatural means to change the sex. As a matter of fact, a German scientist has recently produced hundreds of hermaphroditic guinea pigs, but here is an oyster who actually changes his or her sex at will, if an oyster may be said to have a will, or as previously outlined, when given a nice warm bath becomes male or female, dependent upon temperatures, etc



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Some months ago we published an article on a proposed pipe line for transporting coal from the mining regions in New York, and now we have the proposal of a Canadian expert for piping grain across a great part of Canada, or to be exact, for a distance of some 1,400 miles. The expert in back of this scheme suggests that a pipe line, through which the grain will be blown at a velocity of three hundred miles an hour, could be built for approximately one-fiftieth the cost of a railroad, and that it could be used to transport wheat, oats, barley, corn, or flax. The territory covered is shown in the map. At various points along the pipe line, grain could be brought in from adjacent territory in the manner illustrated, by motor truck, railroads, etc.

Grain Pipe Line 1,400 Miles Long

By RAY DYMENT

A PIPE line to blow grain 300 miles an hour for a distance of 1,400 miles has been proposed in Canada to carry grain from Winnipeg to Montreal.

Mr. R. Patrick of Galt, who has made a study of the situation for the past two years, says that such a pipe line could be built for about one-fiftieth the cost of a railroad, and could be used to transport wheat, oats, barley, corn or flax.

The pipe line would be heavy concrete smoothly enameled inside, one foot in diameter, laid three to four feet under ground over hill and dale, at river crossings on supports costing less than one-twentieth of a railroad bridge, right of way costing little in comparison, and maintenance of way practically nothing.

A steady stream of air at the rate of 300 miles per hour would be forced through the pipe with a possibility of 400 miles per hour being developed.

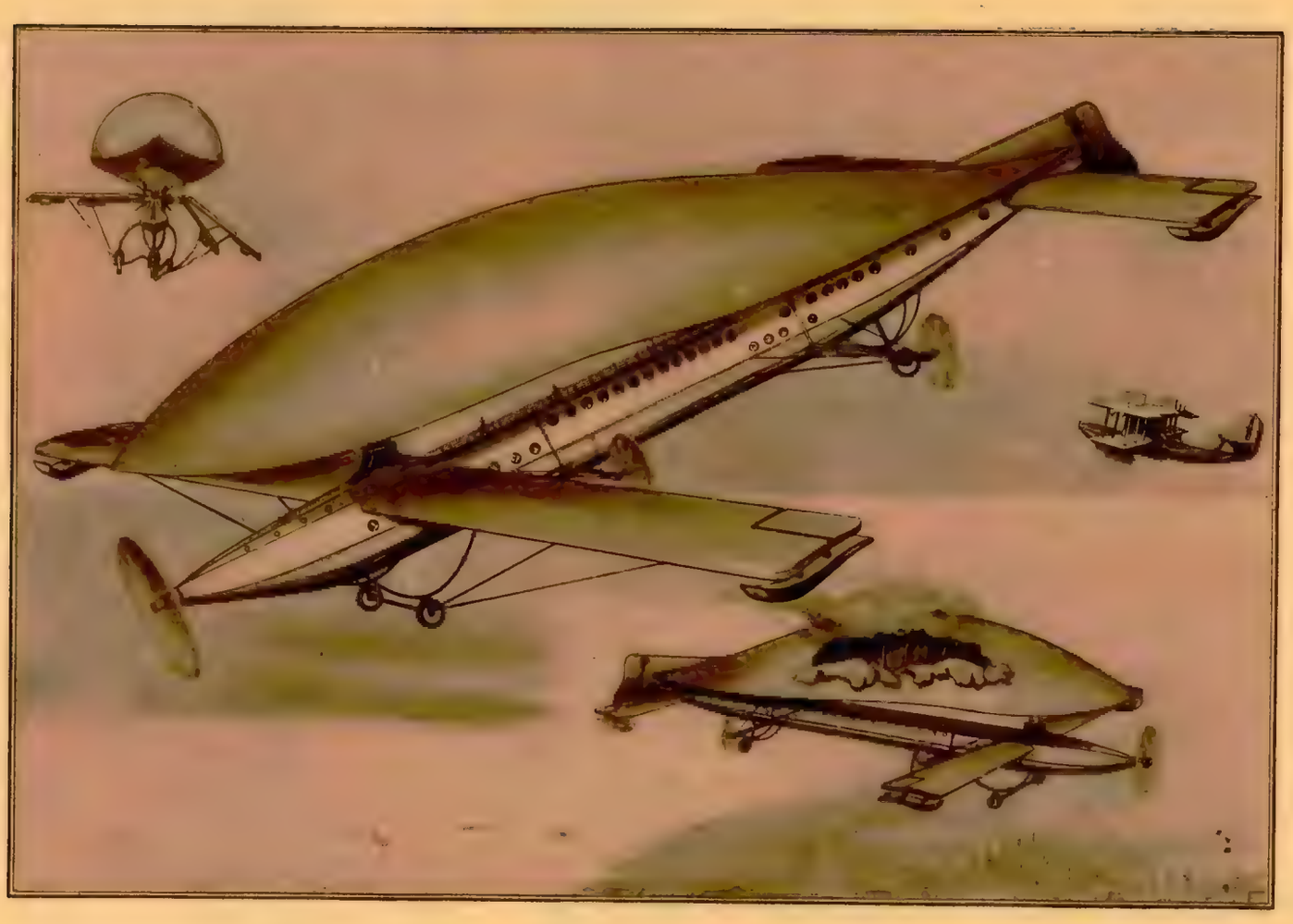
At 300 miles per hour the grain would travel five miles per minute or 26,400 feet. The grain is fed into the pipe at the rate of one pound to every foot of that rushing tornado, or say not over a few grains to each of the 1,728 cubic inches in that foot. Wind at 100 miles per hour will carry sand hundreds of miles over the desert, and the same bulk of sand is two and a half times the weight of wheat—the heaviest of grains

What will stop wheat in a 300 mile blast? It means that the minute you start feeding in the grain at Winnipeg in a little over four hours it will start discharging in Montreal 26,400 lbs. of wheat per minute, 26,400 bushels per hour, or 633,600 bushels per day.

It is well known that a pea may be shot almost clear across the street with a puff of the breath, while it has air resistance to overcome the minute it leaves the tube, whereas the grain in this pipe would have no air resistance to overcome.

Reducing Hematite To Magnetite With Methane

During recent experiments on the reduction of iron ores with fuel gases carried out at the Pacific Experiment Station of the Bureau of Mines, Berkeley, California, it was noticed that at temperatures up to 800° C. (1472 F.) the methane in these gases was practically inert as compared with hydrogen or carbon monoxide. A number of experiments were then carried out with mixtures of methane and hydrogen over a wide range of temperatures to find out when the methane would begin to function actively as a reducing agent. While it reacted slowly at all temperatures tested, its reaction in the reduction of hematite to magnetite, the first stage in the reduction of iron, did not become sufficiently rapid to be of industrial importance until temperatures of over 900° C. (1652 F.) were used. A rough approximation of the velocity constant of this reaction was made for all the temperatures at which tests were made in order to obtain some unit figures of value in designing industrial apparatus for carrying out this reaction. The details of these experiments are contained in Serial 2382, which can be obtained from the Bureau of Mines, Washington, D. C.



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The air liner shown above is a new type of craft recently patented. It combines the lighter and heavier than air machines, and is so arranged that damage to either the gas bag or the wings will still permit the vessel to continue on its journey without danger to the occupants thereof. Note particularly the streamline design of the gas envelope.

Airplane-Dirigible Can't Fall

Airliner Arranged to Combine Advantages of Both Types of Craft

ARE we heading toward this type of aircraft? It would seem from the numbers of patents which have been recently taken out on combination lighter and heavier-than-air machines, that eventually slow passenger liners, that is slow in comparison to future speeds, will be hovering everywhere, not only because of their comparative comfort and safety, but also because of their smoothness of operation, their speed, and their general defiance of weather conditions.

Orphee Langevin, a British inventor, has patented the type of aircraft shown in our accompanying illustration. The description which follows will be of great interest to those who look forward to departures from the heavier-than-air and lighter-than-air machines. The device resembles a dirigible having its nacelle equipped as an airplane, thus obtaining a combined dirigible and airplane, having the features and advantages of each, and avoiding any disadvantage attending the use of either alone.

The fuselage of the airplane is the nacelle of the dirigible, as is clearly shown in our illustration. The upper portion of the dirigible itself is substantially semi-circular in cross-section, and its bottom is flattened and cambered to provide a plane that cooperates with the planes of the airplane, to sustain the aircraft while in flight. Although the under surface is flat transversely, it is so curved as to produce convex surfaces at the front and rear ends, with an intermediate concave surface. This peculiar curvature gives a general streamline surface to the gas balloon. Of course, the angle of incidence of the surface must be carefully regulated. The bottom of the gas bag is made of thin aluminum, and the entire body of the plane could be constructed of the same material. At any rate, cross bracings and struts throughout the gas bag are preferably made of this material.

The combined nacelle and fuselage extends for the entire length of the dirigible envelope, and is equipped at its forward end with a tractor propeller driven by the usual engines. In addition to that, amidships we find other propellers, each driven by individual engines. In order to permit this craft to descend on land, a framework is arranged at the front and rear end of this nacelle. A pair of wheels are secured to the forward end of this landing gear, and one single wheel is placed at the rear. A pair of pontoons are mounted beneath the front and rear wings at their ends to permit the craft to alight upon or rise from the water.

A decided advantage in this type of craft may be noted in the mounting of the amidship propellers, which can be swung through an angle of 90 degrees from their present or running positions, permitting them to act as helicopters.

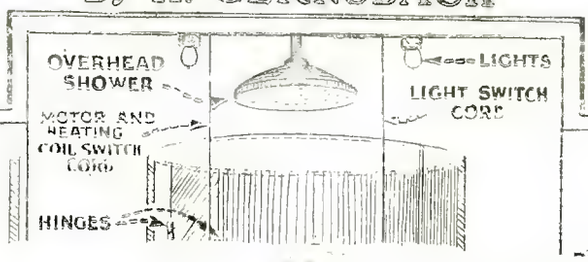
The interior of the nacelle is equipped to comfortably carry a relatively large number of passengers in addition to the crew, for whose convenience portholes are found throughout the ship. A companionway, or promenade, protected by a guard rail on either side, permits either passengers or crew to walk from one end of the ship to the other. In event that any part of the gas balloon be ruptured, the ship could still maintain its position in the air and even continue its journey, as it is so designed that the planes themselves could lift the entire weight of the ship, or the dirigible could lift the plane if the wings were broken. There is little danger that both plane and gas balloon would be damaged simultaneously, while the ship is in flight.

As is well known, when a gas balloon reaches the higher air strata, the cold air causes the gas in the balloon to contract, the balloon consequently loses its buoyancy. In order to overcome this objectional feature, heated gases from the exhaust of the motors are delivered to the spaces surrounding the several gas compartments. These pipes are so distributed that the gases will heat to an even temperature the entire contents of the dirigible compartment. The bottom of this dirigible may be ripped open, so that should the machine fall because of insufficient buoyancy and broken wings, it would still act as a parachute, its descent being relatively slow. The details of this ripping arrangement are given in the patent.

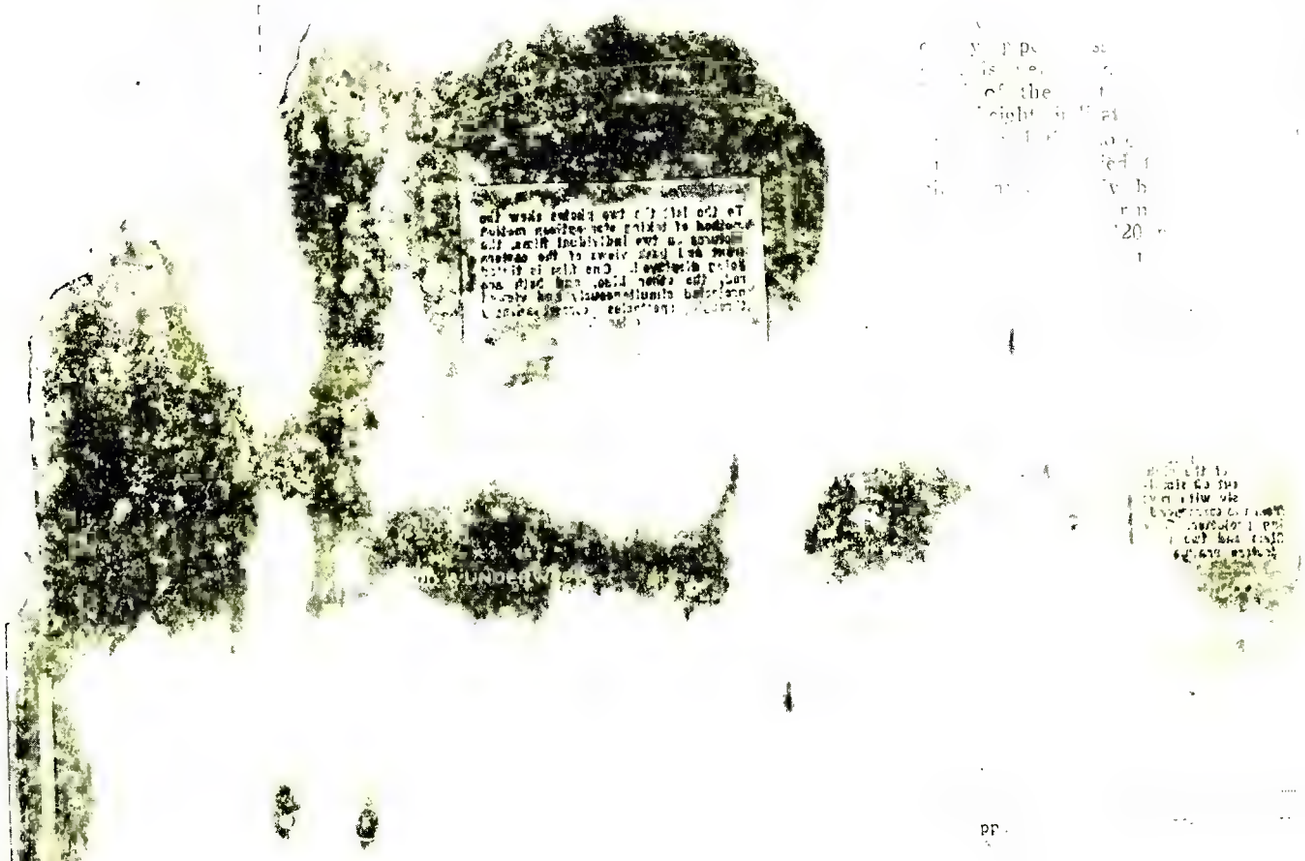
Bath de Luxe

By H. GERNSBACK

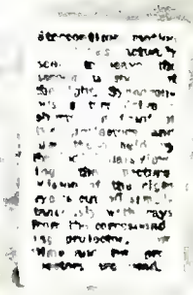
Picture below: side sectional view of vertical bath tub proposed by Mr. Gernsback as a departure from the time-worn horizontal bath tub, which frequently occupies a great deal of valuable space.

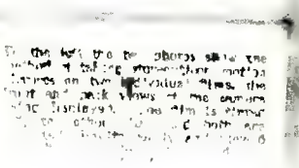


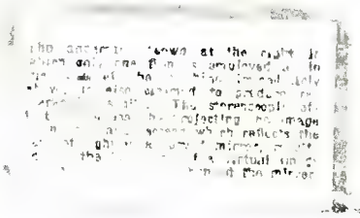
Below is illustrated a top view of the vertical bath tub, and the arrangement of the water pipes and jets in the two folding halves with rubber connections, so that the half sections can be opened and closed.



(Continued on page 836)







Stereoscopic Motion Pictures

By JOSEPH H. KRAUS

During the past few years rapid strides have been made in the development of stereoscopic moving pictures, so that to-day there are several known methods [illegible] pictures, then color pictures, then [illegible] during the past year and a half [illegible] now the stereoscopic picture [illegible]

[illegible] when the [illegible] appreciable [illegible] stereoscopic [illegible] considerable [illegible] patents have been [illegible] ican and foreign inventors for processes [illegible] to produce true stereoscopic [illegible] of the [illegible] red [illegible] worn by each individual of the audience, others depended upon double projection, still others on combinations of motion pictures and still photographs, or the projection of motion pictures from in back of the screen. The newer advances in this field differ considerably from [illegible]

One of the finest motion pictures exhibiting true stereoscopic effect, which does not necessitate the use of lenses for viewing the object, is a machine invented by Lorenzo [illegible] and called the *Teleview*. Although the patent has been applied for less than two years ago, the machine is already very popular. When pictures are taken for use in this device, a camera having two lenses placed from each other by a distance of 2½ inches, the normal distance between the eyes, photographs the scenes from two different points of view on two separate and individual films. Both cameras are coupled together, consequently they are driven in perfect unison. Both films are then developed, titled, cut and edited in the usual manner, care being taken to see that titling occurs at precisely the same corresponding place in both films. If either one of these pictures are exhibited in a motion picture theatre, they appear to be ordinary flat motion pictures. For the stereoscopic effects, a film is placed into each of two motion picture projectors separated from each other by a distance of about 2½ to 3 feet, the exact distance does not matter, it depending entirely upon the available space found in the ordinary motion picture "operator" room. Both these films being watched, are projected upon the screen at the same time, are thrown one upon the other in such a manner that the images on the flat screen appear to be approximately 1 foot apart at the edges but overlapping in the center as our illustrations clearly show. The picture seems to be blurred completely, but when the same is viewed through a simple attachment mounted on a flexible arm on each side of each chair perspective pictures are seen. Objects appear to be three or four feet from the observer and right over the heads of the audience in front of him.

In addition to two ordinary motion picture machines driven from the same shaft and motor so that they run synchronously, the picture, interrupted by the ordinary shutter before being thrown upon the screen, is further interrupted by a large shutter having three apertures. This revolves at such a speed that each frame of motion picture film is thrown upon the screen three distinct times with the projector at the right and also three times with the projector at the left, making in all six distinct pictures which are projected in the short space of time usually occupied by but one frame. A synchronous electric motor drives this secondary shutter. Synchronous motors of the three-phase type likewise drive [illegible] duminum plate which spins before the eyes of each observer. This plate is also shaped like a motion picture shutter, and because of the fact that it operates on the three-phase circuit, having a permanent [illegible] connected to the shutter, [illegible] exactly in step with the shutter [illegible] machine. This [illegible] to

February Articles in Science and Invention

The Sky Splitter Hath Risen. [illegible] *By Charles Frederick*

The [illegible] Elevator. By H. [illegible] Told of this story by the [illegible] scientific fiction [illegible] author of "The War of the Worlds."

The European System of Television Pictures Across the Atlantic. By Dr. L. [illegible] Isakson.

Oscillatory Power and the Tick Doctor Illustrated. By Dr. Alfred G. [illegible]—Our Berlin Correspondent

What We May Expect of New 12 Inch Telescope. By Isabel M. Lewis, M.A., of the U. S. Naval Observatory.

The Malarial Mosquito and How the Disease is Transmitted—Illustrated.

How to Use Your Camera—Part 2.

The Secret of the Old Master Violins Solved. By Dr. Albert Neuburger.

Fish Which Hang Up Their Lamps. By Dr. E. Bade.

Man's Chances Against Insects. By [illegible] Calvin Waterbury.

Synthetic Silk—How It is Made. By Samuel Wein, Chemist

New Stage Makes Dwarfs of Us.

Production of High Vacua in the Laboratory. By Raymond B. Wail.

the observer is covered, at the same time the picture from the corresponding projector is interrupted; then immediately thereafter the other eye is covered and the picture from that machine is interrupted by its respective shutter and so these interruptions continue rapidly, first permitting the picture to be viewed with one eye, then with the other, giving in this manner the true stereoscopic effect outlined. The longest period of time through which either eye can see the picture on the screen without interruption is 1/96th part of a second. But because of the retention of vision of the eye two steady impressions in both eyes are obtained, and because these pictures are slightly different in respect to their relative positions on the screen, the aspect of solidity is obtained. The screen itself vanishes while the characters and the foreground seems to move forward through the air to within grasping distance. In addition to the shutter on both the projector and the disc through which the observer looks at the screen, there are no changes made in the apparatus used for projecting pictures ordinarily. Two projectors are operated simultaneously and corresponding films are employed. Alternating current is used to actuate the shutter [illegible] causes motors can be [illegible] greater certainty and [illegible] by means. A strange [illegible] was demonstrated by the writer which [illegible] the [illegible] [illegible] [illegible] observer [illegible] [illegible] [illegible]

THE ART are many people who have heard [illegible] just [illegible] lying on the tab[illegible] and talking [illegible] ordinary per[illegible] How many ha[illegible] paper [illegible] columbian [illegible]

[illegible] transf[illegible] [illegible] [illegible] [

Stream of Water Lifts Itself

WHEN you first glance at the headline it sounds like another perpetual motion pipe dream, doesn't it? Or about the same logic as that involved in the immortal fable of the man who lifted himself by his own boot straps. However, when we make a closer investigation of this new self-contained water lifting machine which requires no pumps, engines, or wind-mills, to make it work, and which is known as the *hydrautomat*, we find that it is based on the logic of basic mechanical laws after all, for only part of the stream of water is lifted. In other words, this apparatus, devised by an American, Thomas G. Allen, graduate of Washington University, St. Louis, and now a British subject, converts the kinetic energy of a large quantity of water flowing at a low head, into that of a smaller quantity of water at a high head, and part of the water is discharged back into the stream again during the pumping cycle.

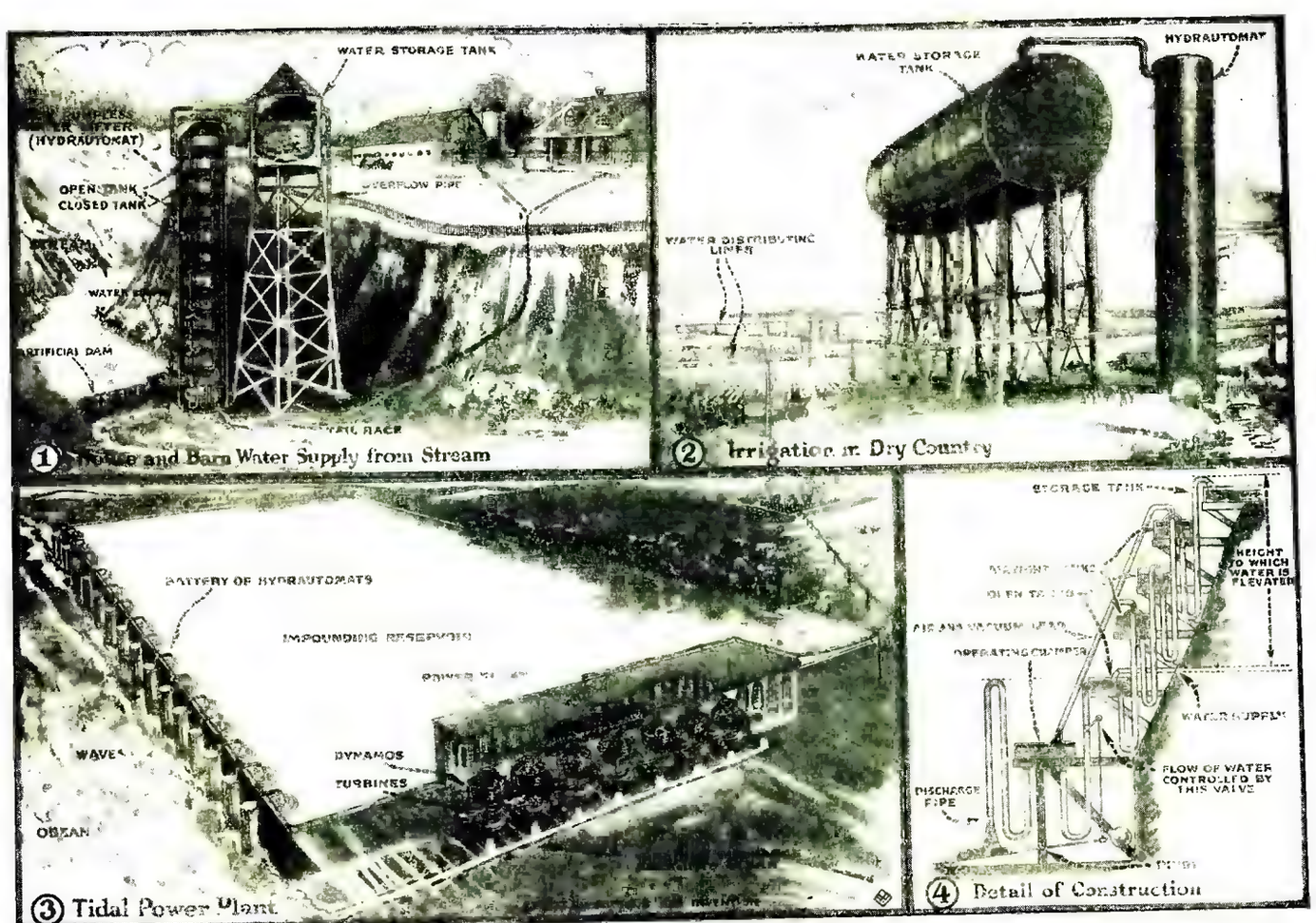
Mr. Allen's invention has been hailed as one of the greatest advances in many years in the realm of hydrostatics, and has been highly praised by no less a scientist than Sir Oliver Lodge himself. The illustrations herewith show several possible applications of Mr. Allen's invention. The first one shown is for house and outbuilding water supply on a farm or elsewhere. The hydrautomat is placed near a brook or stream, and connected with water impounded by a dam or with some supply, so that a suitable working head is made available. The water from the bottom of the device then discharges periodically into a tail-race which leads into the stream below the dam, all of which will be understood by following the detailed description of the device and its action given below, and illustrated in detail in the fourth figure.

This method of raising water will no doubt find many applications in arid parts of the country, for irrigation purposes, as shown in Fig. 2, and among many of its other possibilities we find that of utilizing the power of the tides as they rise and fall. One of the illustrations given herewith shows the hydrautomat, or rather a battery of them, arranged to utilize the power of tides, or ocean waves, employed in connection with a large storage reservoir equipped with suitable outlet pipes and low pressure water turbines, along the same lines as the tidal power schemes now being tried out and advocated in Europe.

Broadly, the apparatus devised by Mr. Allen converts the contained energy of a large quantity of water at a low head into that of a smaller quantity of water at a high head, compelling a stream to hoist up part of itself over the land at higher levels for agricultural or other purposes. It may also be arranged to operate on pressure from a muddy river in order to lift the clear flow of an adjacent clean stream. Suppose that in a river there is an available fall between an upper level, which may be called the head-race, and a lower level, or tail-race. Half way between them is constructed an *operating chamber* which is supplied by an intake pipe from the head race, while from it goes a discharge pipe to the tail-race. Above it, and to the required height, is constructed a series of tanks, closed and open alternately, which may either be placed one directly above the other or arranged like steps up a hillside. These are inter-connected by pipes. Each closed tank is also coupled to the operating chamber by an air-conducting pipe, and their combined capacity is equal to that of the operating chamber. Operation is confined to two strokes—pressure and then suction. The pressure is created by the weight of the water column flowing into the operating chamber from the head-race. Its effect is to compress the air in this chamber and force it out along the air-conducting pipe, from which it enters the overhead closed tanks. The water in these tanks, which has been lifted by the preceding stroke, is thereby forced out and pushed up into the next tanks, which are open ones. Thus at the end of this pressure stroke the operating chamber and open tanks are full of water, but the closed tanks are full of air.

During the suction stroke the contents of the operating chamber are discharged downwards into the tail-race, the inlet from the head-race being at the same time closed automatically. Vacuum is thus produced in

(*Continued on page 892*)



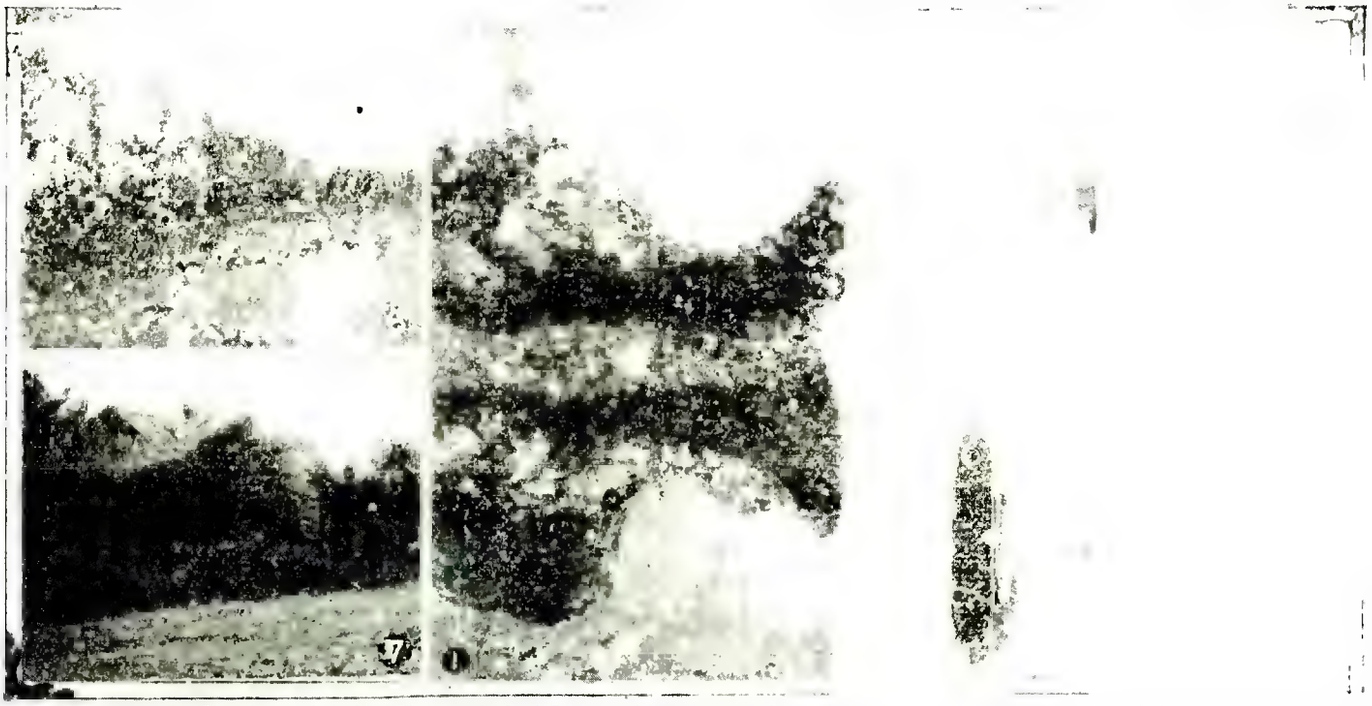
The pictures above show the latest invention for raising water by utilizing the energy in a stream or other body of water, without the use of turbine, water wheels, etc. Figs. 1, 2 and 3, show various practical applications of the "Hydrautomat," as it is called, while the sectional drawing of the apparatus actually installed, and working at the present time in England, is given in Fig. 4 at right. As will be seen, it is not a perpetual motion scheme, and part of the water from the stream or supply is wasted in causing the apparatus to lift a certain part of the water which flows into the operating chamber. The operating chamber is also located a fair distance below the level of the water supply, as the diagram shows, to obtain the "working head." The accompanying article explains fully just how this device works, and while it is novel and ingenious in the extreme, the careful reader will see that it is not a perpetual motion idea as might be imagined at first, but simply a clever adaptation of the laws of nature.

The Latest Novelty in Tight-Rope Walking for Stage Performances. The Rope Is a Composite Affair, Comprising Two Oppositely Charged Cables, Which Are Short-Circuited by the Feet of the Performer. Various Steps Are Taken Along the Rope. The Waving Flame Effect Is Produced in the Manner Indicated, With Fans, Silk Ribbons, and Colored Lights.

Competition of Indian Mi... Makes Lumber

A FEATURE that renders it almost im- ... American men pro- ... meth- ... Indian ... Boys ... min- ... of ex-

United States follows ... strifing crudities than in Indi... little hope of establish... mical duty. Wages ... Nature, it is important to modify mining ... so that more mechanical ... may be employed, for ... man per day may thereby be greatly ... continuous ...



Several Very Interesting Experiments in Taking Photographs With Polarized Light Are Here Pictured. [illegible] Mirror and Method of Attaching It to a Camera Are Shown in Figs. 2 and 3. Note the Remarkable Cloud [illegible] Water Being Much Clearer Than the Actual Sky Photo. Notice the Greater Contrast of the Sky and Clouds in Fig. [illegible] With the Polarizing Mirror. Figs. 6 and 7 Show Two Experimental Pictures Taken [illegible] the Camera in Certain Directions

Photos With Polariz[illegible]

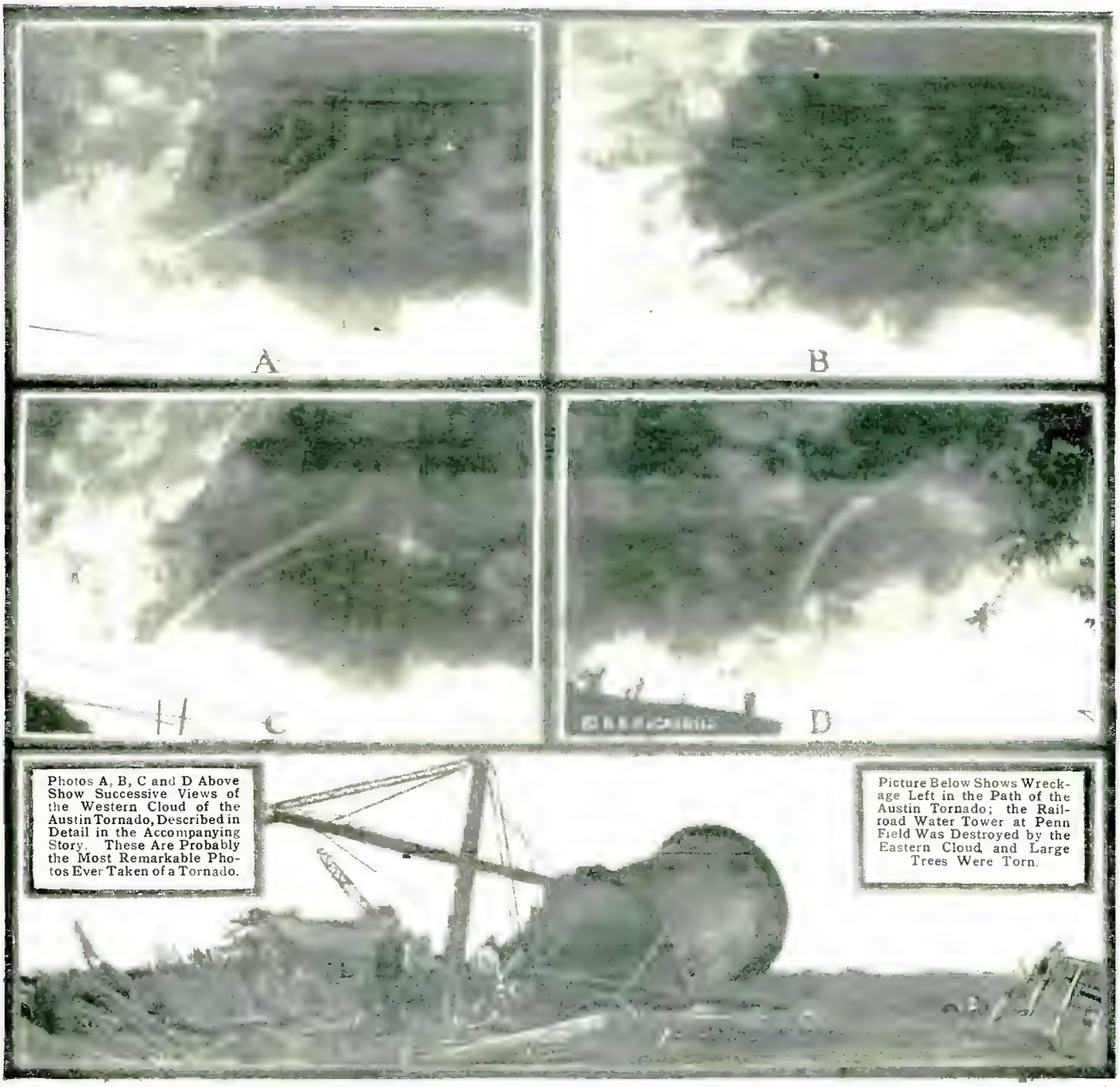
By Prof. LINF[illegible]

PHOTOGRAPHS of sky reflections in still water frequently show very fine cloud effects as viewed in the water, compared with the cloud effects as seen directly in the sky. For example, in the accompanying photograph of Mirror Lake in the Yosemite Valley [illegible] of cloud [illegible] by the [illegible] photograph of the sky [illegible] the water

Daylight Mo[illegible]

By [illegible]

AT LAST a practical solution to the problem of daylight projection of moving pictures has been found and the trials, which were recently held clearly proved the claims of the inventor to be justified. We shall thus be able to enjoy our "movies" next summer even if we are in the open with [illegible]



Photos A, B, C and D Above Show Successive Views of the Western Cloud of the Austin Tornado, Described in Detail in the Accompanying Story. These Are Probably the Most Remarkable Photos Ever Taken of a Tornado.

Picture Below Shows Wreckage Left in the Path of the Austin Tornado; the Railroad Water Tower at Penn Field Was Destroyed by the Eastern Cloud and Large Trees Were Torn.

Remarkable Tornado Photos

THE five accompanying pictures show successive stages of the Austin, Texas, tornado of May 4th, 1922, and the following vivid description is taken from a report by Mr. Fred Morris, co-operative U. S. Weather Bureau observer, at the University of Texas. The four photos show progressive stages of the western cloud wind spout, while the fifth photo shows the damage to the water tower at Penn Field destroyed by the wind spout of the eastern cloud. Large buildings were wrecked by this tornado and houses were lifted up bodily and smashed in much the same fashion as the destruction here pictured of the water tower. We learn from Mr Morris:

At about 3.15 p. m., what appeared to be cumulus clouds at a very high altitude and moving rapidly were observed coming in from the southwest. Below these and coming in from a point somewhat east of south could be seen ragged patches of dark cloud. The scud floating rather low and at a high velocity was coming in from all directions south of a line drawn east and west through the university. These clouds formed rapidly into a huge ugly looking mass with a very low, densely black base and high pink summit. This new cloud was building up at a point somewhat east of the original cloud and about half way between it and the town. The development of this second cloud was very rapid, also, it seemed to be moving southward as it developed. At about 3.45 p. m. the first sharp peal of thunder was heard. Up to this time the sky below the bases of these clouds had remained practically clear, but now began to show dark streaks, indicating that precipitation had begun.

By 3.50 p. m. a definite movement southward of both clouds was in progress. The eastern portion of the original cloud had become obscured by the second cloud, and lightning was more frequent. It had grown dark enough to make artificial lighting necessary in the buildings.

As the second cloud moved southward there was a visible lowering of the central portion of its base. There was a violent churning action about this protuberance, and the whole base of the cloud seemed badly agitated. No true tornado funnel had as yet developed in connection with this cloud, but the projection was lowering and the agitation becoming more violent as it moved southward.

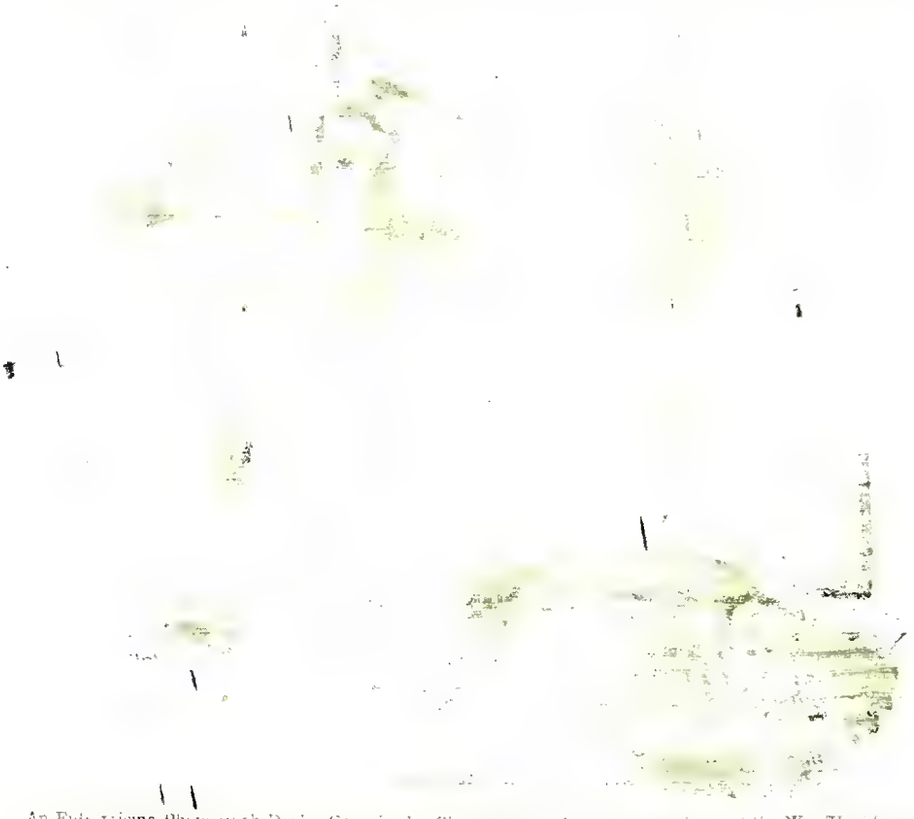
The destructive winds from this cloud were first felt at the State Cemetery, where some branches were torn from trees. At this time it had the appearance of being only a fierce whirlwind.

From this point on the funnel-shaped cloud could be clearly seen. Viewed from the high downtown buildings it had the appearance of being a whirling, churning mass of clouds. Observers could clearly see the materials of the structures thrown high into the air as building after building was struck.

(*Continued on page* 914)

Music Draws Customers

A [illegible] thought of a novel idea for attracting customers to his phonograph shop. By means of a phonograph placed inside a cold chair [illegible] on the sidewalk, and another talking machine with the horn placed near the window of his shop, music was delivered in



An Enterprising Phonograph Dealer Contrived a Clever Scheme to Attract Passers-by to the Way He Worked It Out Is Illustrated Above. The Phonograph in the Show Window Is Fitted With an Electric Motor and Repeating Device, and People Are Attracted by Hearing the Music Apparently Through the Plate Glass Window. A Separate Phonograph Operated by an Attendant in the Basement Actually Supplies the Music Which [illegible]

pleasing tones. [illegible] by the [illegible] consisting from [illegible] see in the window [illegible] to see the [illegible]

Photographing Stars by Daylight

MR. MAURICE HAMY has described for the Academy of Sciences experiments of great interest which he has carried on in the photographing of stars in daylight.

The experiments of Lord Rayleigh have shown that the light of the sky is produced by the diffusion of the solar light by the earth's atmosphere, but the quantity of light dispersed from each region of the spectrum is inversely proportional to the fourth power of the wave length. The sky, therefore, emits very little red light, and if it is examined closely through a screen of this color, which will only let light of long wave lengths pass, the light of the sky will be greatly diminished. The stars, on the contrary, radiate for the most part a great or less quantity of red light and still retain a sensible amount of [illegible]

It is possible then to photograph stars in daylight if there is placed before the photographic objective a deep red color screen and if we use special photographic plates sensitive to extreme red rays. A. Fabry and H. Lindemann have [illegible] photographing stars of the first magnitude even when 20 or 30 degrees from the sun.

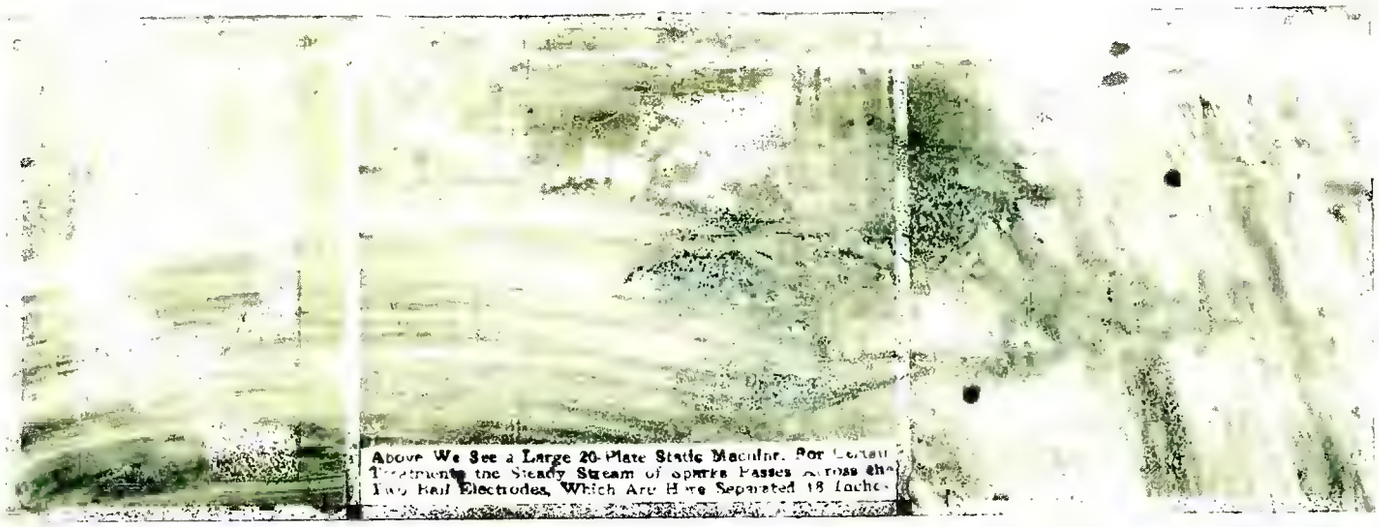
Mr. Hamy now proposes the determination of the limiting size of stars which it is possible to photograph in full daylight through a deep red color screen.

His method consists in photographing the one time the expanse of sky through a red color screen and the incandescent tungsten filament through a photometric wedge. The filament is arranged with its long axis parallel to the axis of the wedge, so that its brightness is such that at such point where it barely can be seen without absorption [illegible] for the same quantity of light as a star of the first magnitude. The wedge is graduated so as to correspond to stellar magnitudes.

As the time of exposure is greater the filiage of the filament as seen through the wedge is impressed upon the sensitized plate [illegible] in length, the portions of the [illegible] the thicker portions of the wedge [illegible]

[illegible] photographic [illegible] maximum permissible [illegible]

Mr. Hamy finally [illegible] that under the condition under which he was working a lens of [illegible] aperture would have permitted [illegible] stars in full day of the sixth [illegible] on the very least



Above We See a Large 20-Plate Static Machine. For Certain Treatments the Steady Stream of Sparks Passes Across the Two Ball Electrodes, Which Are Here Separated 18 Inches

At the Left Is the Apparatus for Administering Faradic and Sinusoidal Currents. Direct Current May Also Be [illegible] Purposes. At the Right Is a High-Frequency Machine Which May Be Employed for a Number of Purposes. The X-Ray Tube Shown in This Photograph Is Operated by Current Obtained From This Machine. The Patient Seated in the Chair Is Receiving Diathermic Current Treatment

New Electro-Medical Ideas

ELECTRICITY for the treatment of various ills and ailments is gaining rapid strides among the medical profession. Its action in the relief of gout has met with marked success. Some glands have been stimulated by its application, and the growth of others has been retarded. For headaches and nearly every other ailment, electricity has been quite successfully employed.

Its method of administration differs with each individual case, and various types of currents are made use of. The high-frequency currents, particularly those classed under the heading of diathermic currents, have been employed by a famous New York physician, not only in the relief of gout, but also in preventing a general stasis and in invigorating the entire body.

There are two methods in use for applying this current. The first is a general application over the entire body, and the second is a strictly local application over the affected area. We can by the degree of current vary its effects, so that tissues may be destroyed or may be built up. It is produced by either a large-sized twenty-plate static machine, or else by a high-frequency apparatus, such as shown in our illustration. An electrode is placed upon the area to be treated, and another immediately under this part. The electrodes are generally of metal, and cut to the area. The current is then sent through a series of burners, and conducting cords lead to the apparatus. For each 1,000 milliamperes of current which is to be applied [illegible]

[illegible] part of the current is very strong [illegible] been found that when this current is permitted to pass through the body, a sensation of internal heat, which seems to start [illegible] of the body and proceed out [illegible] generally experienced. This sensation [illegible] only felt by the patient treated, [illegible] sometimes [illegible] this current originates [illegible] The current is generally mild [illegible] the patient for twenty minutes [illegible] and the next in the [illegible] with less danger and [illegible] the employment of [illegible] short duration of time. [illegible] currents, the skin [illegible] becomes [illegible] nature of the [illegible] is entirely unchanged.

This statement is easily verified by passing a current of a greater volume through a very [illegible] noting the direction in which the current passes. Then when we apply a milder current from different angles to the potato, we will find that when the potato is cut into, the center of the potato is mealy and cooked, whereas at the point where the strong current exerted its maximum influence, this same effect would be seen, except that the heat has acted upon the points immediately below the electrodes.

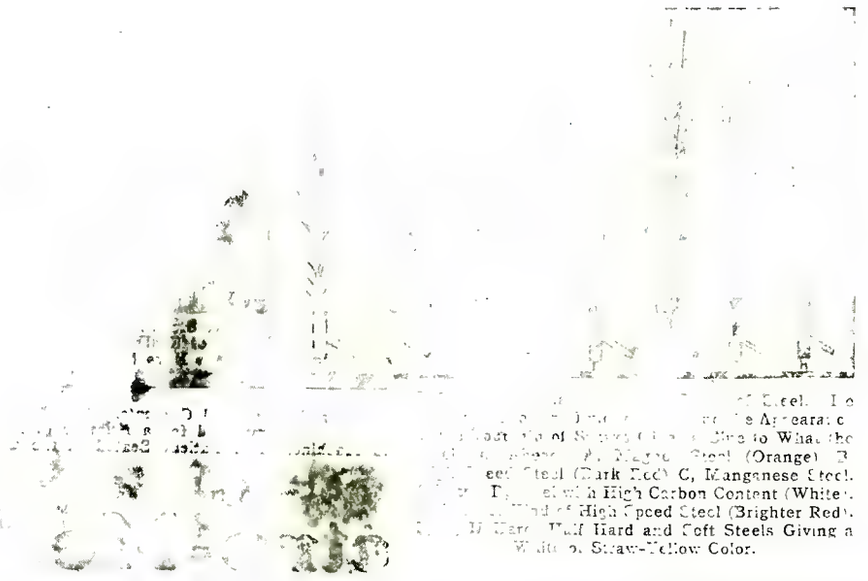
The oldest method of applying high-frequency current of a diathermic nature is in a large spiral cage. This method is not in use in this country to any great extent at the present time. The condensation couch or chair is the one in general use.

These high-frequency currents possess a preference along blood vessels. The alimentary canal and all the abdominal viscera being plentifully supplied with blood vessels permit the passage of large amounts of this current. This stimulation produces marked effects on the gastro-intestinal tract and results in improved nutrition.

In the auto-condensation chair, the chair and footrest are covered with sheet metal. Over this is placed an insulating plate of fiber or mica. On the arms of the chair are round wet metal knobs for the patient's hands. One side of the D'Arsonval solenoid is attached to the back of the chair and the foot rest, and the other side to the knobs of the chair. The patient is then requested to remove his shoes. His hands are [illegible] and the machine is started, and [illegible] the current [illegible]

[illegible] For this purpose, a medium [illegible] employed, because [illegible] patient [illegible] being [illegible] and the [illegible] Larger rapidly, and the [illegible] in the body, [illegible] the [illegible] these [illegible] Large current [illegible] thus [illegible]

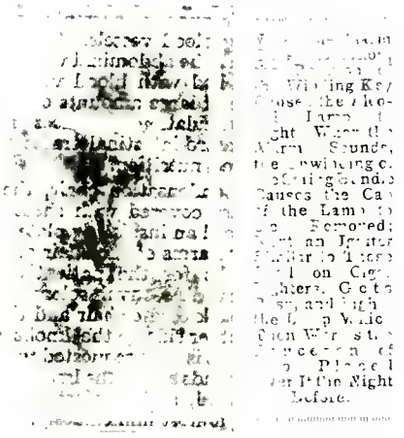
[illegible] conditions [illegible] [illegible] [illegible]



Steel. In ... the Appearance ... Due to What the ... Steel (Orange), ... eed Steel (Dark Red), C, Manganese Steel. ... with High Carbon Content (White). ... of High Speed Steel (Brighter Red). ... Hard, Half Hard and Soft Steels Giving a ... to Straw-Yellow Color.

... and ... of a ... be ... a ... to the ... Take, for ex... carbon steels, and see how they ... If the sample contains ... will give simple rays straight ... which will be illuminated by little ... which are more and more numerous ... of carbon increases, while ... become sharper and thinner ... containing a high percentage of ... the stream of sparks is shortened. ... sparks are produced at the ex... and the whole becomes dazzling ... Steel containing 18 per cent. of ... gives few rays and those of a ... red.

Light Alcohol Lamp

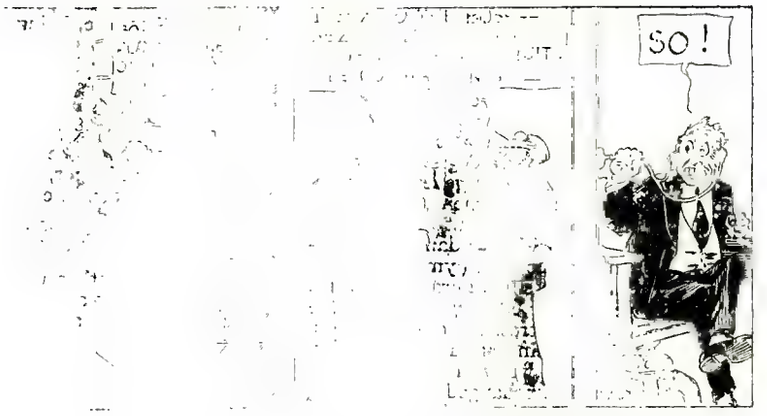


... Whistling Key ... close the Boi... Lamp ... ght When the ... Alarm Sounds, ... the Whistling ... String and ... Causes the Cap ... of the Lamp to ... Removed; ... an Igniter ... similar to Those ... used on Cig... ...hters. Gets ... Red and Light ... the Lamp Wick ... Then Withdraws ... Succession of ... Placed ... ter In the Night ... Before.

THIS little invention, which is original and ... invented, devised by a clock maker ... Mr. Cranhill, consists of an arrangement ... connected with an alarm clock which is put ... to action by the rotation of the alarm key.

The moment that the alarm sounds, the ... string actuates an alarm which takes ... the cap off the lamp located beside it; then ... an igniter of ferro-cereum alloy, familiar to ... cigar and cigarette smokers, is caused to ... spark and lights the lamp, which at once be... to warm the saucepan of liquid which was ... on above it the night before.

This apparatus, which we have used ourselves, never fails and while it does not solve ... the crisis in the domestic service ... nevertheless can be of use to ... people who want to wait for the last ... before leaving the bed.



... Saper-Sensitive Stethe... ... Doctor Isn't Consult... Fooled by ... and ... cerning ...

... Showing at the Left of Artist Paul's ... the Cute Way a Loving Hubby May be ... Final Picture We See How ... the Boss May Easily Keep Tabs on His ... Employees Seldom Hear Good About Themselves."

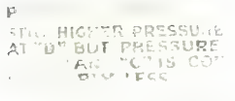
Scientific Problems and Puzzles

By ERNEST K. CHAPIN

4 OF A SERIES

AROUND THE WORLD IN TWENTY-FOUR HOURS

TALK about your cheap methods of transportation, why not go up in a balloon and remain suspended in the air until the earth has



NINE A WITNESS

[illegible] testify [illegible] some dramatic [illegible] which the lawyers question them. I [illegible] you see any flaw [illegible] the witness [illegible] you last [illegible]

Witness: On the 28th of the month (the night when the crime was committed).

Attorney: About what time of the night do you see him?

Witness: About midnight.

Attorney: Was there any moon that night?

Witness: There was. (After glancing at a calendar on the wall the witness adds:) The moon was in its first quarter.

Attorney: In what position was the moon in the sky at the time?

Witness: (After a moment's hesitation.) [illegible] high in the sky [illegible] nearly due south. Was this situation [illegible]

PARLOR [illegible]

[illegible] time [illegible] to [illegible] longer [illegible] ob- [illegible] form [illegible] common [illegible] usual [illegible] ing the [illegible] end of a spool. [illegible] the paper cover [illegible] pin to the [illegible] shown in Fig. [illegible] then blowing the [illegible] the spool against [illegible] surface of the [illegible] or paper. Contrary to all expectations, [illegible] vigorously attempt [illegible] although it [illegible] in no way [illegible] spool. In what way do you account [illegible]

MAGIC [illegible]

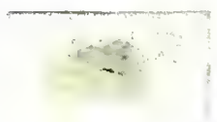
Place two [illegible] vat of a color [illegible] paper across the [illegible] and then invite [illegible] bers of the [illegible] to come forward and try to blow [illegible] up [illegible] the operation between them [illegible] can account easily for the strange behavior of the [illegible] pin.

(For answers to these puzzles see page [illegible])

Pocket Telephone For Police

[illegible] panying [illegible] and diagram [illegible] of pocket telephone [illegible] ed by Mr. William [illegible]

Below, we see [illegible] how pocket tele- [illegible]



[illegible] circuit across the two wires, and when the instrument is laid down, the mercury changing to a different position, causes the circuit between the two wires to be opened.

The microphone member, which is necessary for interpreting the sound waves [illegible] through the cheek bone to the [illegible] the instrument, consists of well known type, [illegible] to the side wall of the [illegible] any vibrations transmitted [illegible] Likewise commu- [illegible]

[illegible] success [illegible] police [illegible] ments in several [illegible]

Phil [illegible] Yori.

MAGNET [illegible] OR RADIATORS

[illegible] should be framed of [illegible] with clean water to insure a good circulation. Old oil should be drained from the crankcase [illegible] very often neglected. [illegible] damage [illegible] fact that they [illegible] to open and close [illegible] under the [illegible] to accomplish these operations is by an electromagnetic drain cock. [illegible] water in the radiator [illegible] may be drained off by [illegible] button situated on the dash of the car. [illegible] extension [illegible] its construction. [illegible]

The device described [illegible]

CONTRIBUTED

[illegible]

ELECTRICITY ON THE FARM

[illegible] In order to win a [illegible] the development of small [illegible] key-stone [illegible] You will be [illegible] and [illegible] photographs [illegible] to the [illegible] following [illegible]

Contributed by [illegible] A. Jun[illegible]

THIRD PRIZE, $10.00

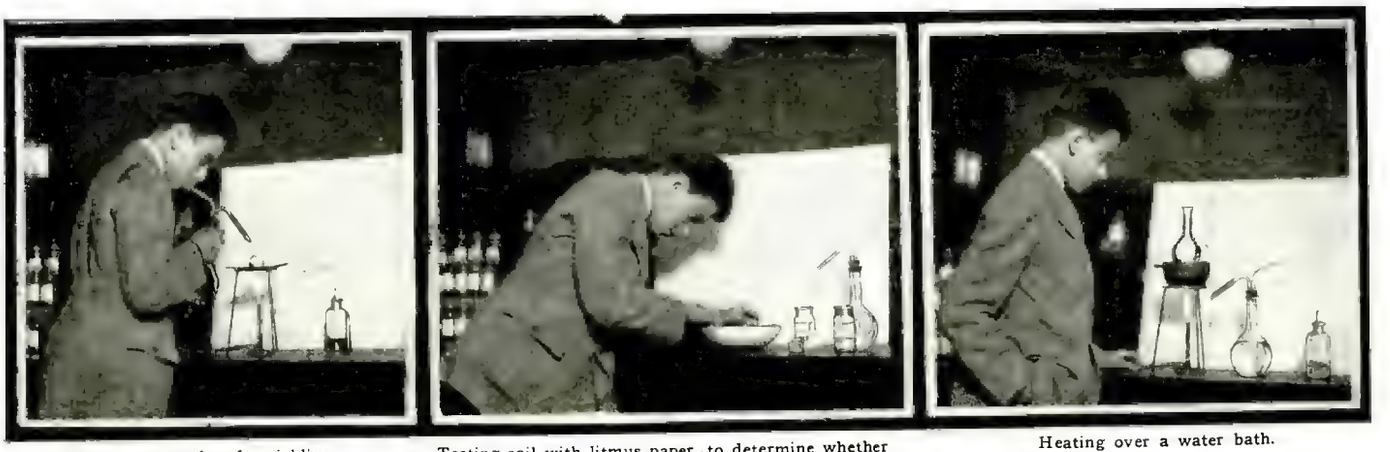
ELECTRIC PRIMER FOR COLD WEATHER

[illegible] cup, [illegible] as [illegible] resistance [illegible] 919)

Practical Chemical Experiments

By Prof. FLOYD L. DARROW

CHEMISTRY OF THE FARM



Slaking a sample of quicklime.

Testing soil with litmus paper, to determine whether it is acid or alkaline.

Heating over a water bath.

NOWHERE else does chemistry in its relations to daily life have more important applications than on the farm. Ever since Justus von Liebig in the middle of the last century began to turn his knowledge of technical chemistry to the solution of the problem of agricultural fertilizers, the bond of mutual interest between the farmer and the chemist has grown steadily stronger. Especially has this been true in recent years. The numerous agricultural experiment stations in practically every state in the Union as well as the agricultural colleges afford abundant evidence of this fact. The farmer himself in many instances is becoming a chemist. He analyzes his soil, tests his fertilizers and feed, determines the butter fat in his milk, and studies the chemistry of insecticides and building materials. No longer does the modern farmer blindly follow the ancient "rule of thumb." The ways of his father and grandfather have ceased to be good enough for him.

Soils. Although the physical and chemical examination of a soil will not tell us all that there is to be known about it, nor with perfect certainty for what it is best adapted, yet such an examination will give very important indications.

Nitrogen in Soil. One of the three essential elements of plant food is nitrogen. Only the leguminous plants such as peas, beans, alfalfa, and clover can assimilate nitrogen directly from the air where it exists is such abundance. All others must obtain it from nitrogen compounds found in the soil. Since nitrogen compounds when heated with a base liberate ammonia, it is not a difficult matter to determine the presence of nitrogen.

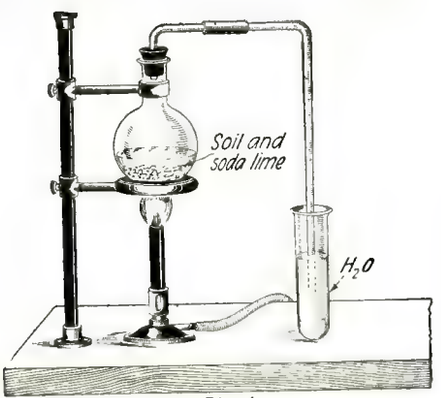


Fig. 1

Figure 1. Determining the presence of nitrogen in soil.

Mix in a mortar 5 grams of the soil to be tested with an equal bulk of soda-lime (a mixture of lime and sodium hydroxide). Place the mixture in a flask having a one-holed stopper and a delivery tube dipping into test tube of water, as shown in Fig. 1. Upon heating the test tube, any nitrogen that may be in the soil will form ammonia and dissolve in the water. Red litmus paper placed in the water will give the characteristic test.

In like manner the nitrogen present in grain, vegetables or meat may be detected.

Phosphorus in Soil. One of the two other essential elements in plant foods is phosphorus. For the detection of this element a solution of ammonium molybdate is required. To prepare it dissolve 15 grams of ammonium molybdate salt in 100 cc. of water with the addition of a little ammonia. If the solution is turbid filter it and pour the filtrate with constant stirring into it 50 cc. of nitric acid and an equal volume of water. After allowing the mixture to stand in a warm place for several days pour off the clear liquid. Place the liquid in a stoppered bottle and preserve for future tests.

To test for phosphorus in soil place about 10 grams of the soil in a flask and add 25 cc. of concentrated hydrochloric acid. Warm the mixture on a water bath for a half hour. A very good water bath may be had by resting the flask upon a beaker of water placed over a Bunsen burner, as shown in Figure 2. After thus heating the mixture, pour off the acid through a filter paper, and gradually add ammonia with shaking until the solution turns red litmus blue. Then add nitric acid drop by drop until the solution just becomes red. Follow this with 10 cc. of the ammonium molybdate solution and wait a few minutes for the reaction to take place. A bright yellow precipitate shows the presence of phosphorus. To aid in the formation of this precipitate it is best to keep the solution at a temperature of about 65 degree Centigrade. Do not heat any higher.

Potassium in Soils. The third essential element of plant foods is potassium. Potassium carbonate is present in wood ashes, but its present source for commercial fertilizers is largely from the Strassfurt deposits of Germany.

It is best to study this test in advance using a brown potassium salt. Make a dilute solution of any potassium salt that you may have. Dip into it a clean platinum wire and hold it in the oxidizing flame of the Bunsen burner. If no other salt than potassium is present, the color of the flame will be a violet or lavender color. If, however, sodium is present the yellow flame of the sodium will completely mask the violet of the potassium. Therefore in order to screen out the yellow sodium flame look at the flame through two thicknesses of cobalt blue glass. Then the characteristic color of the potassium will at once become apparent.

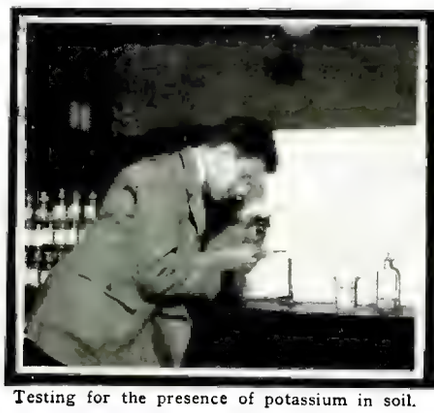
Now digest some wood ashes with water over the water bath for a short time and filter off the liquid. Using a clean platinum wire test the filtrate for potassium as described above. You should have no trouble in showing its presence. Try cigar ashes in the same way.

In like manner digest 10 grams of soil over the water bath, filter and make the test. Since potassium salts are all soluble, you are less likely to find potassium unless you make the test on soil known to have been treated with potassium fertilizer shortly before.

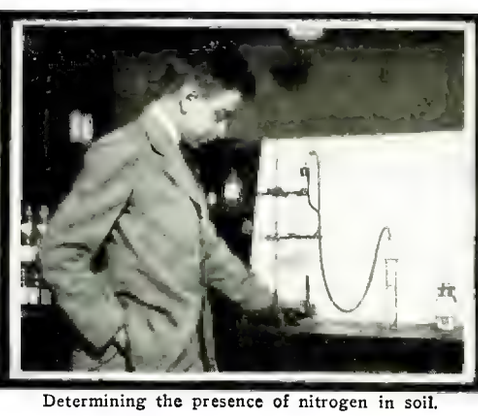
This same test may also be readily applied to a mixed fertilizer supposed to contain all three of the essential elements. And so may the other tests.

Fig. 2

Figure 2. An improvised water bath.



Testing for the presence of potassium in soil.



Determining the presence of nitrogen in soil.

Heating cut-up clover in an iron dish to form an ash.

Reaction of Soils. Soils are usually alkaline or acid. Old soils are acid. As the farmer says they are sour. Such soils are poor and leguminous crops such as beans, peas, alfalfa cannot be grown successfully upon them.

To make the test place strips of sensitive red and blue litmus paper moistened with distilled water in contact with the soil. After a short time note the changes of color. If the red litmus turns blue the soil is alkaline, but if the blue litmus paper turns red the soil is acid.

If the soil proves to be acid, stir in a basin full of it about 25 grams of burnt lime and after standing for a while test with litmus again. The lime will neutralize the acid and the soil will now give an alkaline reaction. The farmer calls this sweetening the soil. Great quantities of lime are used for this purpose through the country each year.

Now try to correct the acidity of soil by using wood ashes instead of lime. The potassium carbonate in wood ashes will neutralize an acid, and also add the element potassium to the soil. Unfortunately wood ashes are not easily obtained in these days.

Fertilizers. In order that a plant may assimilate a fertilizer, the latter must be in soluble form. If a natural product such as phosphate rock is not soluble, it must be made so before applying to the soil.

Phosphorus in Bones. Bone ash is a common phosphorus fertilizer. To about a gram of it in a test tube add 15 cc. of water and from 3 to 5 cc. of nitric acid. Shake the mixture and filter it. To the filtrate add 5 to 10 cc. of ammonium molybdate reagent and warm very slightly. The yellow precipitate obtained, as already learned, shows the presence of soluble phosphate. Now repeat this but do not use any nitric acid. The absence of a yellow precipitate shows that the phosphate in the bone ash did not go into solution in the water alone. Again repeat the test using instead of bone ash acid phosphate such as it is applied to the soil. You now obtain the yellow precipitate and the test for a phosphate. The acid phosphate is made into soluble form at a fertilizer plant by adding sulfuric acid to the insoluble rock phosphate found in nature.

Making Acid Phosphate. In a beaker mix 100 grams of bone meal with 60 cc. of concentrated sulfuric acid stirring the mixture thoroughly with a glass rod. Allow the mixture to stand for three days. Then pulverize it and test for soluble phosphates with ammonium molybdate solution.

Solubility of Potash Fertilizers. Potassium compounds are called potash compounds from the fact that they were originally obtained from wood ashes treated with water in pots. In three separate beakers place 1 gram each of kainit (a potash fertilizer), potassium nitrate, and potassium chloride, known to the farmer as muriate of potash. To each beaker add 100 cc. of water and stir thoroughly. These potash salts readily go into solution and are therefore easily available as plant food. For that same reason they are easily washed out of a soil.

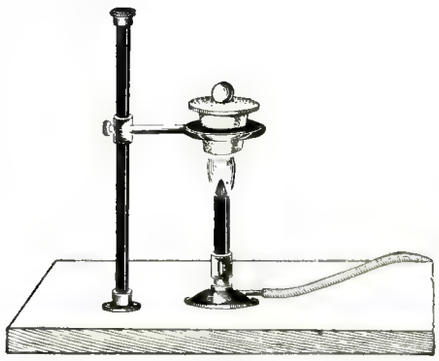


Fig.3

Figure 3. Carbonizing plant tissue.

Volatility of Ammonium Salts. In separate test tubes place 2 grams each of ammonium carbonate and ammonium sulfate. Heat each test tube gently and note that the carbonate is very easily vaporized after which it deposits on the cold walls of the test tube. Also note that the ammonium sulfate does not readily vaporize. Ammonium carbonate forms in the manure of stables, and in poorly ventilated stables vaporizes and deposits on the walls thus wasting this essential constituent of plant food. Gypsum, known as "land plaster" when applied to the manure converts the ammonium carbonate into the sulfate form and thus prevents this loss.

Solubility of Nitrogen Fertilizers. In separate beakers place 10 grams each of ammonium sulfate and sodium nitrate, the two most important nitrogen fertilizers. Add 100 cc. of water to each and stir thoroughly. You will note that both of them readily go into solution.

Action of Fertilizers. In the early days of agricultural chemistry it was supposed that a simple chemical analysis of a soil would tell at once just what elements should be added to restore its fertility. But it has since been found that such is not the case. It is not so simple as that. It is now known that the only sure method to pursue is to make actual growing tests.

In each of several small boxes place about 20 pounds of the soil in question. Leave one box without the addition of any fertilizer. To one add acid phosphate, to another either ammonium sulfate or sodium nitrate, and to a third potassium chloride or sulfate. Prepare another box in which all three kinds of fertilizer have been added in small quantities. Then prepare three more in each of which a separate combination of two of the fertilizers is made. In each case stir the soil and fertilizer thoroughly. Then plant in each box about 25 seeds, corn, beans, wheat, or rape seed. Place the boxes in a greenhouse or a window. When the plants are up thin them down to 16 and let them grow. By careful observation of the different boxes the sort of fertilizer required for this particular soil and crop may be determined with a great deal of accuracy.

Elements found in Plants. Carbon, nitrogen, phosphorus, calcium, and potassium are among the most common and important elements found in plants, aside from hydrogen and oxygen.

Carbon. Place some dry plant tissue from growing beans, wheat, or some other crop in a porcelain crucible. Cover and heat strongly over the Bunsen burner as shown in Fig. 3. The gases which escape about the lid will burn. After a time upon extinguishing the flame a black deposit of carbon will be found on the inside of the crucible.

Calcium. Cut up some clover hay and place it in an iron dish. Heat this over the Bunsen flame strongly until only an ash remains. Transfer the ash to a beaker and add 50 cc. of water and 5 cc. of nitric acid. Heat for a few minutes and filter. Now add ammonia to about 20 cc. of the filtrate until the solution just turns red litmus paper blue. Then add acetic acid slowly until the solution is just acid to litmus. Follow this with 2 or 3 cc. of ammonium oxalate solution. A white precipitate shows the presence of calcium. Lime, which is calcium oxide, is used on soil upon which clover or alfalfa is to be grown and therefore calcium will be found in these plants.

This ash may also be tested for potassium as already described making use of the cobalt blue glass.

The tests for nitrogen and phosphorus have already been given. In the case of phosphorus, however, the plant or seed must be burnt to an ash as in the case of the clover, and the test made upon this ash just as was done in the case of bone ash.

Testing the Quality of Lime. Place a lump of quicklime in an evaporating dish and moisten it well with water. Gently warm the dish to about 35 degrees Centigrade to hasten the action. Presently a very vigorous action results, the quick-lime swelling up and generating much heat in the process. It at the same time crumbles to a powder. If this process is complete leaving but little unslaked material the lime is good.

To about half a gram of the slaked lime in a test tube add 10 cc. of water and then hydrochloric acid a few drops at a time. Continue to add the acid a little at a time followed by warming

(*Continued on page 929*)

Experimental Electro-Chemistry

By RAYMOND B. WAILES

PART 7—CHEMICAL EFFECTS OF THE ELECTRIC CURRENT; GAS AND WEIGHT VOLTAMETERS

IN the past articles of this series we have seen how an electric current is produced from chemical energy. The effects produced by the electric current as affecting chemical changes are by far more important than the mere chemical production of the current which is used to produce the chemical effects.

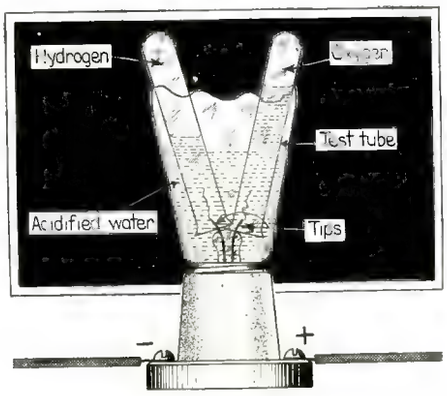


FIG. 1

Water is composed of two parts of hydrogen and one of oxygen, as can be demonstrated by using this apparatus.

The above statement can be illustrated by the following simple equation:

$$Zn{-}2^* \longleftarrow\!\!\!\!- \quad -\!\!\!\!\longrightarrow Zn''$$

Here, a piece of zinc, Zn, is immersed in one of its solutions such as zinc sulphate (zinc vitriol). The metal contains both positive and negative charges, it must be remembered. Two electrons or negative charges (one electron is shown by the asterisk, *, the figure 2 indicating two of them) of electricity are given up by the metallic zinc when immersed in a zinc solution, and some of the zinc passes into solution as *zinc ions*, shown as Zn″. The arrow pointing to the right indicates that the equation can proceed in that direction. Proceeding toward the right, the metal forms ions. This is the case with the electro-chemical cells described previously; the electric current was generated by a metal passing into solution in the form of ions.

The arrow in the above equation which points to the left shows that the equation or reaction can proceed in this direction also. This is just the opposite to the right-handed direction. The equation is said to be reversible, or the reaction a reversible one. When the reaction proceeds toward the left, the zinc ions or zinc bodies in solution give up their charges and become zinc atoms, or just plain zinc metal. This is true in electroplating, and in the above left-handed equation, a current would be required to cause it to proceed in that direction. It is the left-handed reaction which is so useful to man today. The left-handed equation procedure utilizes electricity. The right-handed one generates it. Very little of the electrical energy used today is produced by chemical methods.

CHEMICAL EFFECTS PRODUCED BY THE ELECTRIC CURRENT

Perhaps the simplest example of a chemical effect produced by the electric current is that of the electro-decomposition of water.

Water has the formula H_2O. It is, when pure, not an electrolyte (does not conduct electricity), for *ions are not present in a sufficient amount to conduct the current.* Water does ionize or split up and form cations and anions to a slight degree (0.00001%), but this is not sufficient to allow electricity to pass through it except in the minutest amounts. If sulphuric acid is added to the pure water, an electric current can be made to pass through it, at the same time decomposing the water. This is similar to a left-handed equation of the type given above, electricity causing a chemical reaction.

Figure 1 shows a simple and inexpensive method for the electric decomposition or electrolysis of water. A broken lamp is filled with water containing five or ten per cent. of sulphuric acid. Two test tubes, filled with the same solution are inverted and lowered over the little stiff wire tips which are left intact on the glass inner standard when the filament breaks. On passing a current through the lamp, from several batteries in series, hydrogen gas will be evolved from the negative electrode and oxygen from the positive except as it is attacked by the action. Exactly twice as much hydrogen gas will be formed as oxygen, the latter, if copper electrodes are used, combining with the copper.

Owing to the fact that certain metallic tips mentioned above are attacked by the acid and gas evolved, the simple apparatus as shown in figure 2 can be used. The elements or electrodes are carbon in this case, which is not attacked by sulphuric acid. A cut down and inverted bottle serves as a container for the acid electrolyte.

The hydrogen and oxygen gas are evolved indirectly from the water, for, sulphuric acid ionizes in this manner:

$$H_2SO_4 \longleftarrow\!\!\!\!- \quad -\!\!\!\!\longrightarrow \overset{+}{H},\ \overset{+}{H},\ \overset{--}{SO_4}.$$

On passing a current, the positively charged hydrogen atoms (H with the positive sign above it) pass to the cathode or negative carbon rod. When these unlike charges come together, they neutralize each other and the hydrogen is left free from its charge. In this state, it is molecular or natural, so to speak, and passes off as a gas, which collects in the test tube over the negative carbon pole.

The sulphion (SO_4) is charged negatively as a dyad, as the two lines (indicating minus charges) above it shows. The whole group, or radical, as it is called, travels to the anode or positive pole, for it will be remembered that unlike charges attract each other. Upon contact with the positively charged pole, the negative charge carried by the sulphion is neutralized and the free sulphion, SO_4, reacts with water as follows:

$$SO_4 + H_2O = H_2SO_4 + O$$

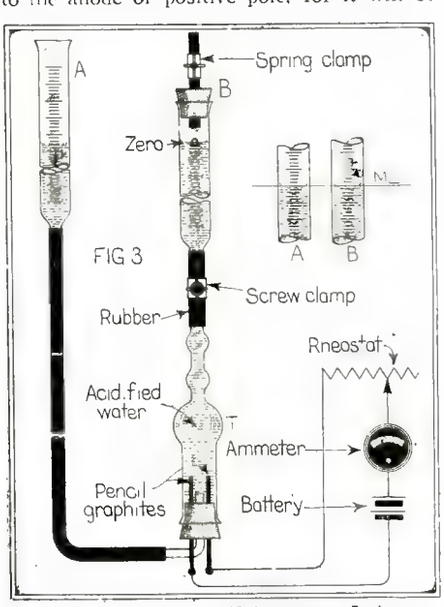
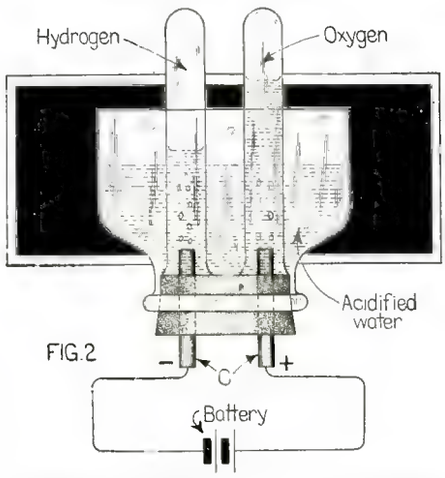


Fig. 3. A simple Gas Voltameter. It is possible with this simple apparatus to check and calibrate home-made ammeters with great accuracy.



A simple home-made apparatus for the decomposition of water.

It is the oxygen, or rather a molecule, O_3, of oxygen (for two atoms of oxygen combine to form the molecule, O_2) which is liberated at the positive pole of the electrolytic cell just made.

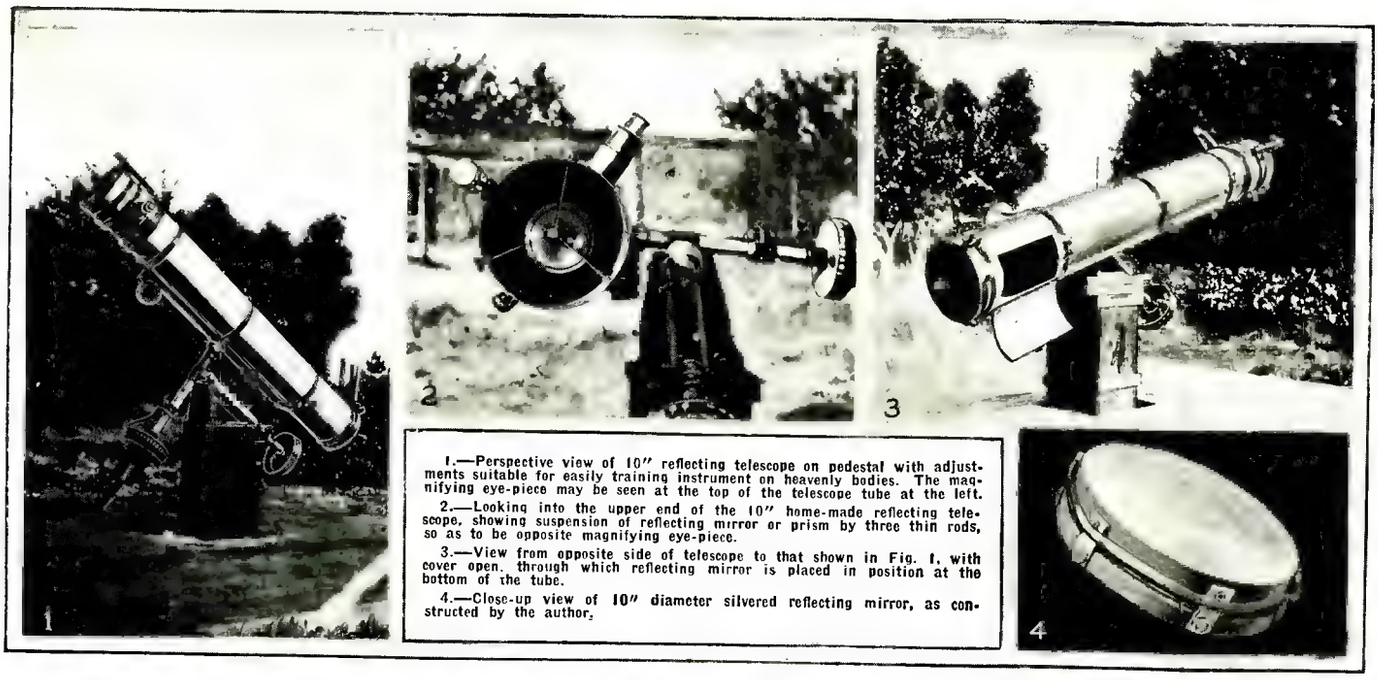
A SIMPLE GAS VOLTAMETER

It would naturally be asked, would a large current produce more gas than a weak one? The volume of both gases produced is proportional to the current passed per unit of time. By measuring the amount of both gases produced, the current which passed during the electrolysis can readily be calculated. By this means ammeters available in the experimenter's laboratory or shop can readily be checked for accuracy, using the simple gas-voltameter as shown in Fig. 3.

The gas voltameter consists of two tubes, A and B. Tube B is graduated in cubic centimeters. Burettes serve admirably for both tubes. Tube B is connected at the bottom by means of a short length of rubber tubing, to a calcium chloride tube having a three-hole stopper in its end. Short carbon rods such as are contained in flashlight cells are inserted through the stopper as shown. The tube A is connected with the lower end of the calcium chloride tube through the central hole, by means of a short length of glass tubing.

In operation, the entire system is filled with water acidulated with sulphuric acid. The battery and the ammeter which is to be checked for accuracy, or the home-made ammeter which is to be calibrated, is placed in series with the gas voltameter. A variable resistance can be used to cut down the current strength so that the entire scale of the ammeter can be checked or calibrated. The pinch cock at the upper end of B is opened and the screw clamp at the bottom is adjusted so that the water in tube B is at the zero mark (top). The spring clamp is then released, *i.e.*, closed. When the level of the water in tubes A and B are the same, as shown by the smaller insert figure, with the spring clamp open, the instrument is ready to use. The spring clamp must be closed during the operation of the instrument, and the screw clamp must be open.

(*Continued on page* 897)



1.—Perspective view of 10" reflecting telescope on pedestal with adjustments suitable for easily training instrument on heavenly bodies. The magnifying eye-piece may be seen at the top of the telescope tube at the left.

2.—Looking into the upper end of the 10" home-made reflecting telescope, showing suspension of reflecting mirror or prism by three thin rods, so as to be opposite magnifying eye-piece.

3.—View from opposite side of telescope to that shown in Fig. 1, with cover open, through which reflecting mirror is placed in position at the bottom of the tube.

4.—Close-up view of 10" diameter silvered reflecting mirror, as constructed by the author.

Build Your Own Reflecting Telescope

AT A COST OF $26.30

By C. E. BARNS

Member American Astronomical Society, American Association of Variable Star Observers, Etc.

Part II.—SILVERING THE REFLECTOR

AN unsilvered mirror will give a very fair image of a bright object like the moon, but a properly silvered one will afford eighty or ninety per cent. of reflection—a colossal advantage. The silvering process then must be done thoroughly and with great care; and is one of the most beautiful experiments in telescope building. Nor is it at all difficult, as anyone who has had any experience in amateur darkroom work will appreciate. For, whereas no darkroom is necessary, the same rules with regard to exact measurements of chemicals, regulations of temperature and above all *cleanliness* obtain in perfect silvering as in perfect negative-making; and there should be neither haste nor guesswork. These chemicals will cost a couple of dollars; but there will be sufficient for half a dozen trials; so if at first you do not succeed in achieving a perfect film, wipe it off with dilute nitric acid and go at it again. If you follow directions you are sure to succeed, probably with your first attempt.

Clean four quart bottles thoroughly, and label: A, B, C, and D.

Solution A—Nitrate of Silver, 175 gr., Distilled water, 10 oz.

Solution B—Ammonium Nitrate, 262 gr., Distilled water, 10 oz.

Solution C—Granulated Sugar, one-half oz.; distilled water, 5 oz. Dissolve and add tartaric acid, 50 gr. Boil in glazed dish 10 min., then add pure grain alcohol 1 oz., and water to make 10 oz.

Solution D—Caustic potash (purified by alcohol), 1 oz., distilled water, 10 oz.

Lay speculum in large earthenware dish, face up. Cut a three-foot strip of stout wrapping paper, two or three inches wide, and run through a dish of melted paraffin. When cold, wrap tightly around edge of speculum and tie securely with cord. This will make a dish to receive the silvering solutions.

With a wad of surgical gauze dipped in pure nitric acid, go over every part of the face of the speculum with great care four or five times. Rinse with distilled water and repeat. Ten or fifteen successive washings of the glass are none too many to insure a perfectly clean surface, for be warned of one thing: if there is a spot of finger grease or other foreign matter on the mirror as large as a pin-head, it will not receive the silver. After the final rinsing, cover glass with distilled water and let stand in same temperature as the chemicals for several hours. At temperature 80° F., the silver deposits best. If warmer, it deposits too fast and is too soft to polish well; if cold, it deposits too slowly.

Place two clean beakers side by side. In the first mix one ounce each of Solutions A and B. In the second beaker, mix likewise one ounce each of Solutions C and D. You are now ready to silver.

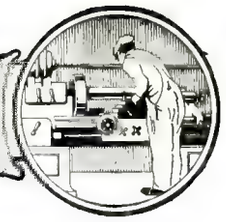
Pour off the distilled water which has been standing on the speculum, replace mirror in dish, then quickly empty the contents of one beaker into another. The solution will turn straw-color, then deepen to brown and thence to inky blackness. At this instant flow over the speculum and rock as when developing a photographic plate. Within a few seconds the silver will be seen to film over the entire disk, and little black granules will form through the solution. At this point, before the solution gets muddy, as it soon will, rinse out the two beakers with distilled water, and mix Solutions A and B, and then C and D, then mix together as before. Quickly pour off the muddied solution from the mirror and pour on the new, rocking again. This will double the deposit of silver. Do this still a third time, and even a fourth, if, on holding the mirror up to the window, the film of silver appears to be too thin. It should not be opaque, but objects dimly outlined through it. Rinse mirror with half a dozen or more changes of distilled water to eliminate all trace of solution, flow over an ounce or two of denatured alcohol and set up in a sunny window to dry. If your glass was clean, the temperatures of chemicals and speculum all equal, and your chemicals guaranteed, C. P., you probably have a mirror that is perfect enough to adjust in your telescope without further polishing, for all ordinary visual work. Still, you will want the brightest surface obtainable—one approaching as nearly 100 per cent. reflection as possible—so, after a day or so drying and hardening in the sun, lay the speculum on the shelf of a stove to warm and prepare for quite a tedious but wholly worth-while job.

From the well-washed jeweler's rouge, which you used in the polishing process, spoon out about as much as would cover a silver quarter. Place in a dish on a stove till bone-dry. Wrap in a piece of new chamois skin and pound to finest powder. The chamois will take up almost enough of the rouge to polish, but a little more may be supplied from time to time. Wrap the chamois around a wad of cotton, then warm over the stove. The mirror should be quite warm now; and beginning at the center, with a light circular motion polish evenly and with extreme care. You will soon be gratified by the result; and after an hour's work your speculum will resemble a polished block of the finest ebony.

You will be so pleased with your accomplishment now that you will be doubly glad that you started building your mounting about the time of undertaking the grinding, for you can hardly wait till nightfall to give your handicraft the supreme test on the moon, double stars, clusters and nebulae as well as the planets. Even with low-power eyepieces you will be staggered with the light-gathering power of your mirror. Theoretically it will give you nearly a thousand diameters with a high-power ocular and perfect seeing; but you will rarely require more than two hundred; and for ordinary observations a power of fifty with a ten-inch is sufficient. It will show the crescent phases of Mercury and Venus; the moons and markings of Jupiter and Mars; the wonders of the trapezium in Orion; multiple star systems and clusters and a thousand celestial marvels, as well as the endless catalog of lunar phenomena, the disk of the moon filling the entire field.

(*Continued on page 907*)

THE CONSTRUCTOR

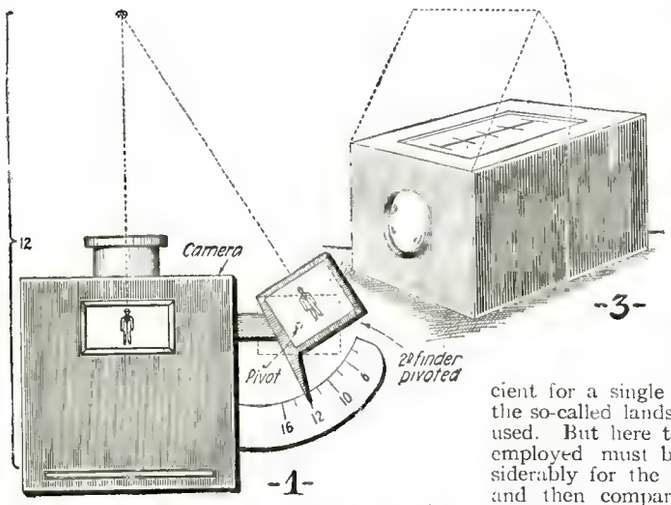


How to Use Your Camera

By Dr. ERNEST BADE

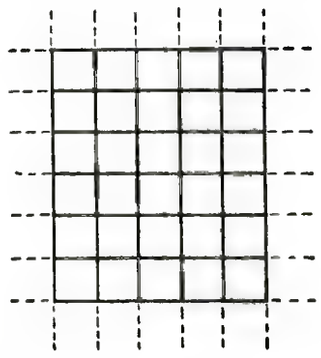
THE CAMERA, THE LENS AND THE PICTURE

A COMPLETELY light tight cardboard box, one inner end of which receives a photographic plate and in the end opposite to this a fine, even pin hole is placed, is the simplest conceivable type of camera. As primitive as this device is, it is far more efficient than is generally supposed. In many cases such a camera is to be preferred to the best type of lens camera, especially for the taking of landscapes and statues. They are always sharp. The picture, which results, depicts the nearest object as clear as the furthest and all degrees of shadow, of light and darkness are exceptionally true to the original. But it has one fault. The picture to be taken must be fully illuminated, and then exposed for a comparatively long time. The picture of a sunny landscape at mid-day requires a time exposure of one minute.



Left: Two view finders, one stationary and the other movable. When the stationary finder is trained on an object, the pivoted finder is turned until the object is on the center line of both. Then the scale shows the distance the object is away and can therefore be correctly focused. The single view finder is divided as told in text.

The square ruled chart shown at the right, makes it a simple matter for anyone to test the lens of a camera in order to determine how correct it is. The lines of this chart, with a good lens, will be reproduced on the focusing glass in exact parallelism.



In the regular camera a lens is used for the reduction of this time interval. A camera may appear and be constructed as it will, it fulfills a part only of its mission if it is light tight. It may be as cheap as it is possible to get it, but the saving of money on the lens is false economy. Today three things are demanded of a lens, its ability to let much light pass, to give a correct image, and to produce clear-cut pictures; but this three-fold purpose is solved by few of them. The amateur requires a universal lens which should not distort the object as is the case with many objectives. The lens must fill the whole plate sharply and distinctly with open diaphragm. An increase in the passage of light through the lens is obtained by selecting a higher numbered objective than that required by the camera. In this case a lens is selected for a 4 by 5 camera which will completely fill, with open diaphragm, a 5 by 7 plate without distortion.

It is an easy matter to prove how correctly a lens works. A square piece of paper ruled in a number of squares, and large enough to fill the plate is attached to the wall. This is then brought to a sharp focus, not reduced, but in its natural size. Then all the lines must be sharp and clear cut, and, above all, they must be perfectly parallel in the center as well as at the edges with both the open and closed diaphragm. When this is the case such a lens can be used for all kinds of work; it is a true universal objective which, in its efficiency, will satisfy the highest demands to which it can be subjected.

Portrait lenses allow much light to pass, but they are not free from distortion at the edges. For this reason only a small surface of the plate can be utilized, but this is sufficient for a single portrait. For landscapes the so-called landscape lenses are sometimes used. But here the iris diaphragm usually employed must be closed down quite considerably for the production of distinctness and then comparatively little light passes through. An advantage is the clearness of the picture. Such an objective consists at least of one crown and one flint glass lens.

The results obtained with these and other specially constructed lenses can also be secured by the amateur just as efficiently if not better, with a double anastigmatic lens. Here the front and back series of lenses are symmetrically built, each pair of lenses consisting of three pieces. If the front series is removed the remaining series can be used as a landscape objective, but it must be remembered that the focal length is then doubled. At the same time a double anastigmatic can be used for the most rapid of snap shots.

When a camera is selected, the one to be preferred is a Graflex. Its mechanism permits the fastest snap shots as well as time exposures, and the picture is visible, plate size, to the last instant. Then the object can be sharply focused. A judgment of distance is not necessary as in the case of the small finders on the ordinary camera where the resulting pictures are, too often, indistinct and blurred.

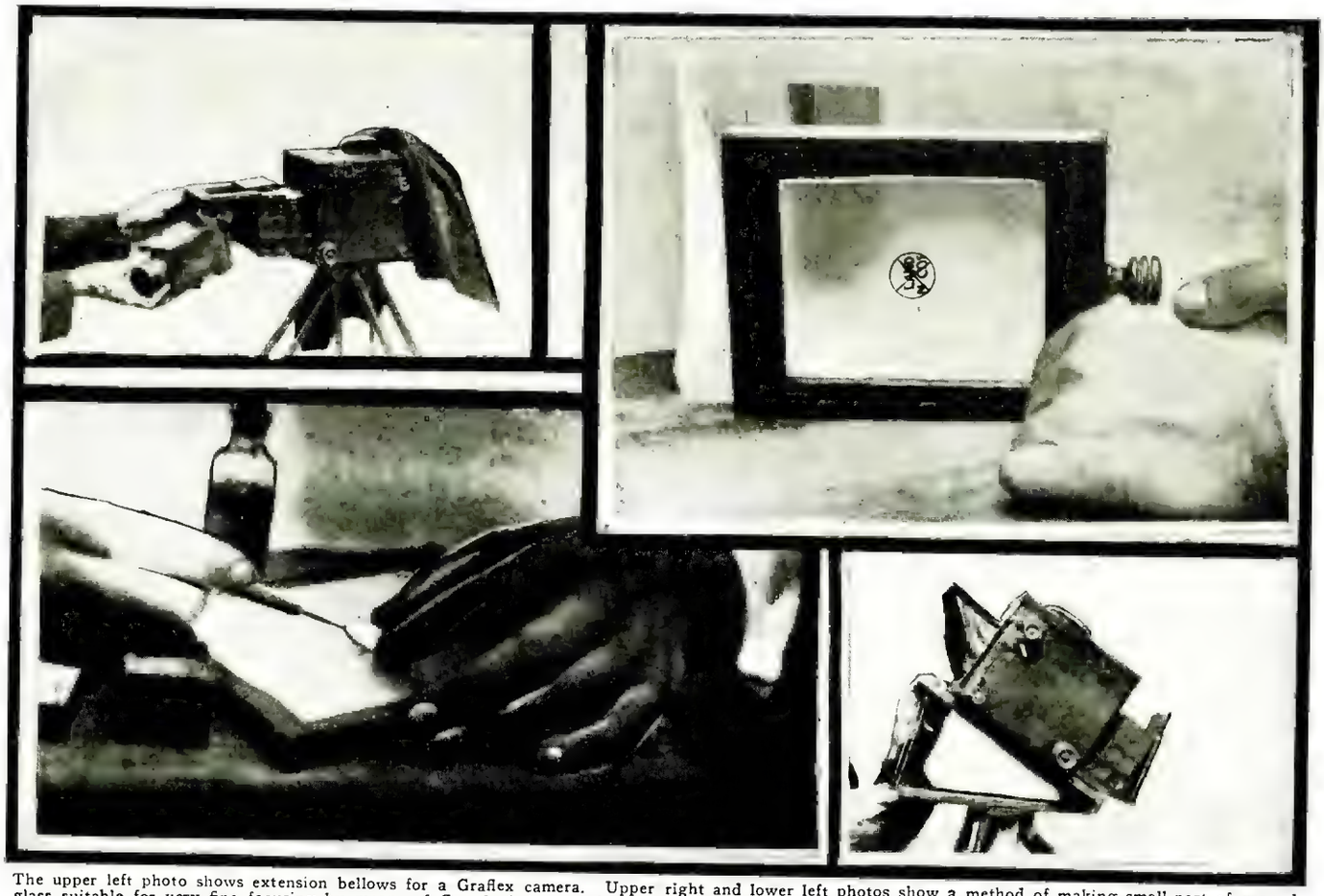
How is the picture now formed on plate or film?

The agent producing the optical and chemical picture is the light. By its means chemical changes are caused in different substances which are extremely susceptible to light. Our plates and films are coated with silver salts and certain definite rays of the spectrum act upon these salts when exposed to them. The silver salts are exceptionally sensitive to light blue, violet and ultra-violet rays which are the chemically active or actinic rays. Much less active are the red, yellow and green rays of light. It is for this reason that the ordinary photographic plate does not give the light values of the various colors as seen by the eye. Only when a violet colored screen or ground glass is used for focusing can the resultant picture be determined before it is taken. Photos taken in the morning or in the evening do not furnish good results, as the yellow rays are then predominant.

The camera is like an eye, it sees all the colors, but the sensitized plate is completely color-blind. It only differentiates between light and dark. It is the ultra-violet rays which are the most active upon the plate, and not the various colors; and as the objective is arranged so as to concentrate these practically invisible rays upon the plate in order to bring forth the picture, the picture in the camera leans strongly towards the blue side of the spectrum, but this is invisible to the eye.

The silver salt upon the plate has the property of changing in proportion to the actinic intensity of light received, the exposed plate, however, showing no change until it is developed. In this process a reducing agent acts upon the silver salt and the image, which really is a deposit of finely divided silver, appears. After developing, the plate still contains silver salts not altered by the light, and if the salt were left on the plate the image would soon be clouded and finally obliterated by the light. Therefore the image is fixed by dissolving the unaltered silver salts. The resultant picture is an inverted image of the picture taken, all dark parts of the object appearing light, and the light parts dark. Only on taking a print from this negative is the approximate tone value of the original object obtained.

After these few technical remarks a little must yet be said about the taking of the picture. All photos must be taken from such a position that the sun does not shine into the objective. Snap shots are only to be taken in a good bright light and then only when the object is in motion. Snap shots of persons taken in full sunlight, are never satisfactory. The light parts are then far too hard and the shadows too black. Such pictures are best taken in a slight shade with a short time exposure or one waits until a white cloud passes before the sun, as the light is then more diffused. As a substitute for such conditions flashlight pictures are only makeshift.



The upper left photo shows extension bellows for a Graflex camera. Upper right and lower left photos show a method of making small part of ground glass suitable for very fine focusing by means of Canada balsam and a thin microscopic cover glass. Note how type can be read through this part of the glass in upper right picture. Note simple method for raising the bed from the tripod on which a Graflex or other camera is mounted. A wire or other metal arm is pivoted to the top half of the bed, and may be clamped or hooked in various positions on the lower part of the tripod.

Daylight illuminates the near object as fully as the distant one, as the sun, the source of light, is for all practical purposes, situated at infinity. The magnesium light (flashlight) flames only a short distance from the object, and illuminates those objects equally which are equally distant from it. According to the well known law of optics, the intensity of surface illumination of artificially lighted objects diminishes as the square of the distance increases. Only a part of the object illuminated with flashlight powder is correctly lighted, all others receive too much or too little.

When using the diaphragm, it must be remembered that the light passing the lens decreases inversely with the square of the lineal opening as it is closed. The more the opening is closed the longer must the exposure be made. And it is only used to give the final picture more depth.

In general the snap shot is under-exposed. These plates or films should always be placed in a weak developer, as such a solution will act more uniformly than a normal or strong solution. The amateur usually employs a developer which is far too rapid in its action. Only when the process is slowed down will the shadows have a chance to develop before the lighter parts become too strong. The white parts, that is those which appear black on the negative, will always be seen first in developing. In the beginning they run over the entire plate, then slow down, and finally half tones will be observed. It is these which must be completely developed. An exposed plate shows but little difference light and dark parts. Such a plate developed with a strong solution. developing then doing little harm, still be too dark, it is an easy weaken or restrain its intensity. To avoid all changes in the grade and developer, otherwise it is possibility to secure uniform posed plates should not be to develop, but it should It is not the picture which gives satisfaction in photography, it is the carefully bringing forth of the invisible picture, its fixing, and the production of the positive or print.

Focusing and Aids in Focusing

The small, simple, and cheap cameras, the Brownies, require no adjustment in the taking of a picture. It is always in focus when the object is seven or more feet away, the exact distance being noted on the circular accompanying the "box." For the purpose of bringing the object or person to be taken in a direct line with plate and lens, a view finder is usually placed above the lens, a device giving a reduced picture of the object to be photographed. The better grades of pocket or folding cameras are also provided with such a view finder. But here the object must first be focused before it can be taken since these cameras are furnished with a short bellows. They are not focused at infinity like the box cameras.

It has already been mentioned that the pin hole camera cannot be focused, the objects in the distance appearing just as sharp as those in the foreground. This cannot be attained with a lens since an iris diaphragm cannot be closed down to such a fine point. For this reason the simplest type of box camera must also be focused to a certain degree and this is accomplished by placing the object at a well defined distance from the camera. The view-finder does not give an answer to this problem, the distance must be judged, and this guessing gives many indistinct photos. The fogginess of the picture in many cases may be traced to a different fault. The distance may be correctly judged, the picture may be sharp, but, at the time of taking the snap shot, the camera moved. It is in these simpler cameras that the snap-shot shutter is thought to be so rapid that the slight movement of the camera while releasing the shutter is negligible. This opinion is absolutely wrong. The camera must be held firm and immovable, otherwise the result will be a distortion of the picture. It is always best to attach the camera to the tripod or other stand even while taking snap shots. Then the object may move, but the camera will not. The fogginess of the picture is increased with the inverse ratio of the distance. The further the object and the smaller it is upon the film, the less likely will it be to suffer from distortion.

There are various ways in which the distance that the object is away from the camera can be judged. The simplest of these is to divide the upper glass surface of the view finder into a number of segments or lines which will then represent the height of a normal man at different distances. For instance five horizontal lines are drawn or scratched upon the glass. If now a normal person covers all lines he will be as close to the camera as the bellows extension will permit. If he covers four then he may be 9 feet away, if three probably 12, etc. The correct distances will, of course, have to be measured with a tape line before the lines are scratched on the glass and the measured distances should either be remembered or written on the camera.

Another method will probably be feasible. This consists of providing two view finders. One is firmly attached to the camera and gives the portion of the picture which is to be taken upon the film. The other is movable and is placed as far to one side as is convenient. The greater this distance is, the more exact will the result be. The rear end of this pivoted view finder carries a scale which reads the distance that the object is away. Both view finders are provided with a vertical line through their centers. The immovable view finder is trained upon the object to be taken. Then the pivoted finder is turned until both lines coincide upon the same object. The scale then gives the approximate distance.

The Graflex has no view finder. Here the entire apparatus is so arranged that the

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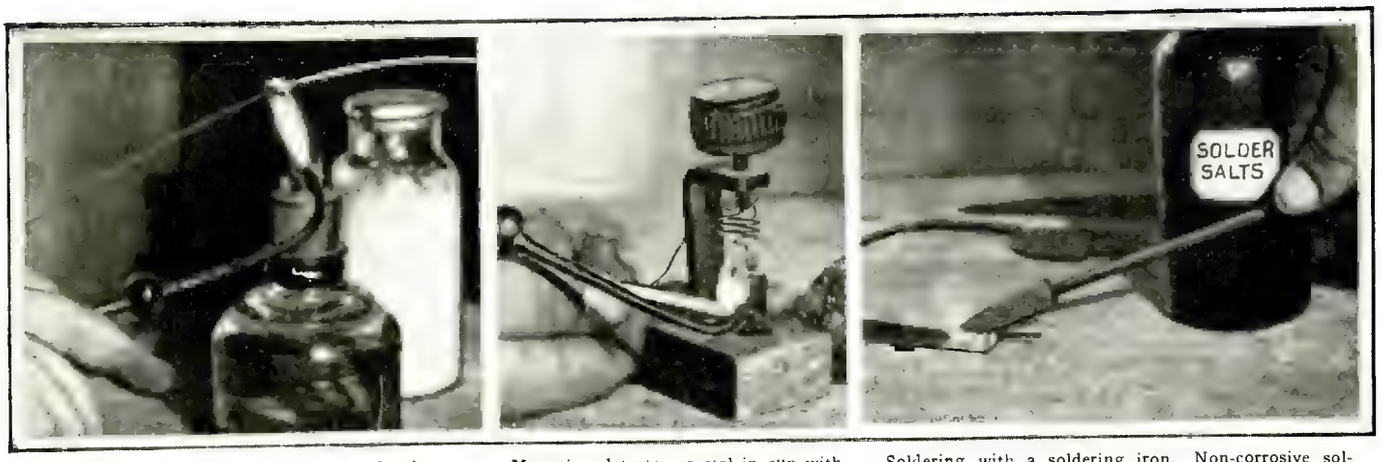


Soldering together two pieces of wire with the blow pipe.

Mounting detector crystal in cup with the aid of a match and a blow pipe.

Soldering with a soldering iron. Non-corrosive soldering salts are very effective for general soldering.

How to Do Soldering--and Alloys

THE metals have influenced, in a striking degree, the progress of civilization. First it was the softer and more precious ones which attained supremacy. Then the harder ones came into use, until, finally, the alloys, which outrank all others in point of usefulness, were developed.

The specific gravity of alloys is rarely the arithmetical mean of their constituents, in some, the density is greater, in others, it is smaller. Then, too, the proportions in which the various metals unite can not be definitely determined. In some cases it is an atomic proportion, in others it may be an arithmetical ratio. All that can be said with any degree of certainty is that the metals are generally soluble in each other and unite, not only by fusion, but even by contact. Under such conditions it can readily be understood what difficulties must be surmounted before an alloy having certain well-defined and specific properties can be produced.

Just mixing and fusing a heterogeneous mass of different metallic elements may lead to no results. In fact, quite a little experience is necessary to compound alloys with any degree of success. Then, too, there are no general rules to follow, each type being prepared in an independent and different manner. Sometimes the more fusible metals are melted first, in other cases the more refractory are heated to a temperature where a perfect union will take place. At the same time a flux is often required, such as rosin or fluorspar, the material depending upon the fusing temperature and properties of the metals employed.

There are many alloys of universally known characteristics and well understood physical properties; other, more or less rare, are the possessors of freakish and little understood attributes. For instance, alloys of tin, bismuth, or magnesium with aluminum, decompose water, setting hydrogen free. Here it is possible that the metals are not perfectly alloyed and it is thought that infinitely numerous particles, exceptionally minute in size, are formed on cooling, which act as thermocouples. Others give abnormal color effects, especially those difficultly fusible elements of iridium, osmium, etc., with aluminum. Gold with various proportions of other elements, such as iron, cadmium, silver and copper, gives us metallic alloys whose color ranges from white to yellow, red, blue and green.

The commonest of all metals is iron and steel, and the simplest way to determine its composition quickly, is to grind a piece on an emery wheel in a dark room, observing the size and color of the sparks emitted. Steel with a high carbon content gives short, star-shaped and white sparks; with little carbon the sparks become much longer besides being straight and yellowish in color. When it contains 18 per cent. of tungsten only a few dark red rays are emitted. Chrome-tungsten steel gives both light and dark red stars with occasional white sparks. Manganese steel produces white sparks, which are interspersed with stars.

A newcomer among metals, and by no means the least important, is the alloy, duraluminum, which came into prominence in Europe, being particularly developed by the Zeppelin firm. It is an alloy of about 4 per cent. copper with aluminum and has the approximate physical properties of steel with just one-third of its weight. This makes it an ideal metal for airplane construction, where a minimum of weight is of the greatest importance and, it is also highly resistant to corrosion.

In the construction of hydraulic cylinders an alloy of copper and zinc, with from 2 to 5 per cent. of iron is used. This combination gives remarkable strength and elasticity and will withstand a pressure of 760 atmospheres. Cylinders of steel will begin to sweat, the interior pressure being so great that the water permeates through the pores of the metal, but with this alloy, the pressure can still be increased without any moisture being perceptible on the outside of the cylinder.

An alloy used for the unique purpose of soldering glass, mending cracked glassware, or cementing lamps made of metal and glass, consists of 3 parts of lead, 2 parts of tin, and 2½ parts of bismuth. This alloy melts at 212° F. Another glass solder which melts at 392° F. consists of 95 parts of tin with 5 parts of zinc. Another of 90 parts of tin with 10 parts of aluminum melts at 734° F. Great care must be taken not only to prevent the glass from cracking, but also to prevent the alloy from oxidizing. It is, of course, best to heat the glass to the requisite temperature and then to draw this alloy over the glass, melting it by the heat of the glass.

Solders, which are generally classed as hard or soft, are alloys of two or more metals used to unite two surfaces either of the same or of different metals, and, as the strength of the soldering depends upon the kind of solder used, the degree of strength required for the joint must be kept in mind. It is very important to remember that the solders must always have a lower melting point than the object to be soldered and the object must be perfectly free from oxides both before and during this process a freedom obtained by some flux. A solution of zinc chloride made by saturating 1½ pints of hydrochloric acid with zinc, 1½ ounces of sal ammoniac in 1 gill of water, 1 ounce of chloride of tin in 1 gill of water, are mixed. If cloudy, add a few drops of fresh muriatic acid. This will clear the liquid. A neutral soldering flux often employed with great success, especially for soft solders, is rosin or tallow (a common candle will often be found serviceable). For harder solders and brazing, a dry mixture of boric acid and sodium carbonate placed on the metal to be soldered is a very good dry preparation as the borax dissolves the oxides formed on the joint.

The harder solders, often called spelters, do not flow below a red heat. A mixture of 58 parts of copper, 17 parts of zinc, and 15 parts of tin produces a white hard solder. Another having a yellow color, but which can only be fused at high temperatures is well adapted for all kinds of iron, steel and bronze, and consists of a mixture of 53.3 parts of copper, 43.1 parts of zinc, 1.3 parts of tin, and 0.3 parts of lead. Soft solders melt at much lower temperatures. Typical formulæ of soft solders are:

Bismuth	Tin	Lead	Melting Point Fah.
	1	2	464°
	1	3	432°
2	1	1	392°
5	2	3	374°
	5	3	374°
	2	1	365°
	5	2	356°
1	2	2	320°
2	3	4	297°
1	2	1	266°

The number of parts indicated for the different metals are taken by weight, while the last column refers to the melting temperature in the Fahrenheit scale, the temperatures being approximate.

These solders, which are easily prepared, are well adapted for any general work not requiring special strength.

Still other alloys melting at much lower temperatures are much used in automatic fire extinguishers of the sprinkler type. These are also in demand for mounting crystals in crystal detector cups. These consist of:

Bismuth	Lead	Tin	Cadmium	Melting Point Fah.
5	2	3		212°
7	6		1	180°
8	4	2	1	150°
16	11	3	2	170°
8	8	3	10	167°

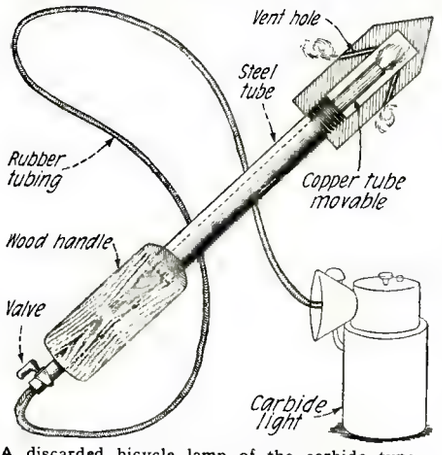
HOW-TO-MAKE-IT

This department will award the following monthly prizes: First prize, $15.00; second prize, $10.00; third prize, $5.00.
The purpose of this department is to stimulate experimenters toward accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department a monthly series of prizes will be awarded. For the best idea submitted a prize of $15.00 is awarded; for the second best idea a $10.00 prize, and for the third best a prize of $5.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $15.00

GAS-HEATED SOLDERING IRON

A unique soldering iron can be very easily constructed with material found about the workshop, particularly if an ordinary calcium carbide lamp, such as is employed on bicycles, is on hand. If this is unobtainable, a calcium carbide generator could be constructed at but little cost. The accompanying diagram shows in detail how this soldering iron is made. A rubber tube passes from the calcium carbide generator to the handle of the soldering iron, where the pipe



A discarded bicycle lamp of the carbide type, and the special soldering iron shown above, constructed out of old parts, is very serviceable for experimenters who cannot heat their irons by means of electricity.

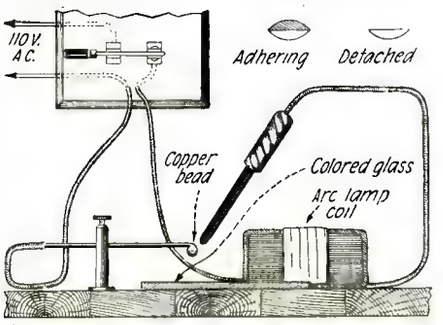
terminates in a small tip, around which is placed the soldering copper. This copper has been drilled out from the reception of the pipe, and several air vents drilled obliquely into the same. In the iron which I used, only two air vents were supplied, but the number of these openings will have to be determined by the experimenter. To light the iron, the copper is first removed and the gas turned on. It is permitted to pass through the iron for a minute or so, to expel all air, after which the gas is lighted, the copper screwed back into place, and the iron is permitted to heat up for a few minutes. Inasmuch as the amount of gas can be regulated, the heat of the soldering copper will be evenly maintained. Studying the sketch will enable the experimenter to construct one of these devices easily.

Contributed by CLARENCE ANAMIER.

SECOND PRIZE, $10.00

PRODUCTION OF ARTIFICIAL GEMS

This may at first sound misleading, for no furnace is used nor are the chemical constituents of a gem taken into consideration, in fact the scope is only hindered in the shape of the product and the various colors of glass obtainable. The glass should not be colored on the surface only (which can be told by looking through it from a broken edge), but of even color throughout. The diagram will explain the arrangement of the apparatus. A very good coil of the kind that is used in arc lamps of a reactance of 9 ohms or so, will do. The arc is best struck



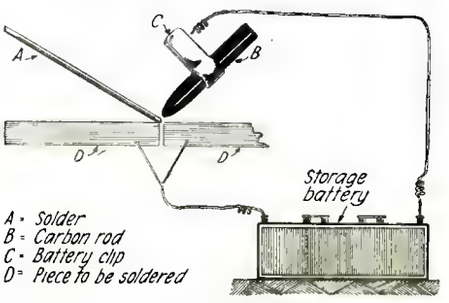
A very interesting experiment is the making of artificial gems out of copper and sheets of colored glass. The manner in which the apparatus is set up is depicted above.

by hand, resting the fore arm on the table to steady yourself, and just as the copper bead drops, withdraw the carbon. Shortly a snap is heard and when cool the bead can be pried from the glass, the glass adhering, but quite easily separated by the edge of a knife. The glass is usually of the shape shown in cut, varying somewhat in depth and shape. A word to the wise: the height the bead drops from is very important, for if the bead spatters it will imprison air bubbles and not be round in shape. A height of 1 inch is usually correct. Goggles should be worn for convenience in observing the bead. The finished gems I made would readily scratch glass, due evidently to the hardening they had undergone.

Contributed by GILBERT P. MILLER.

SOLDERING WITH ELECTRICITY

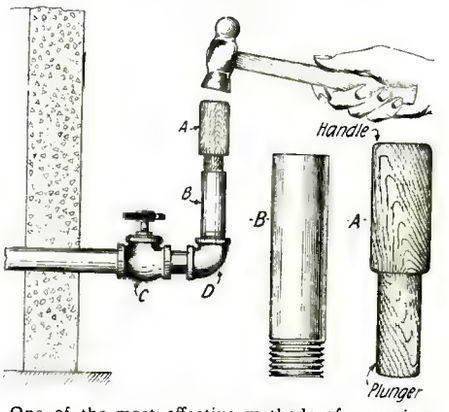
To solder successfully with electricity the following apparatus which most amateurs possess are required: An old arc light carbon, or small carbon rod, a storage battery (of preferably high amperage), storage battery clip, and several feet of flexible wire. As seen in the illustration, one terminal of the storage battery is connected to the battery clip, and this in turn is clamped to the carbon rod. The other terminal of the



Your storage battery can be used for soldering purposes when no copper is available. The results are surprisingly good. Simply arrange the apparatus as shown above and solder the joints by the heat developed by the arc.

battery is fastened to the metal that is to be soldered, (or if two pieces are to be joined the lead is connected to both). After all connections are made, a little paste is applied to the joint to be soldered. The stick of solder is placed on the joint so that it will make contact, and the end of the carbon rod is touched to the solder directly over the desired spot. The heat generated will melt the solder, after which the carbon may be used as an iron to smooth out the work, as each time the carbon is touched to the metal, the resulting arc generates heat sufficient to join the pieces securely together. If a battery clip is not available, a block of wood with a hole bored through it large enough to admit the carbon rod may be employed or a clothes pin may be used.

—Contributed by FERRIS W. SULLINGER.



One of the most effective methods of removing rust from iron pipes in which the flow of water has been materially decreased, is to vibrate the column of water in the pipes, as shown in the diagram herewith. The article explains the action more fully.

THIRD PRIZE, $5.00

RUST REMOVER FOR WATER MAINS

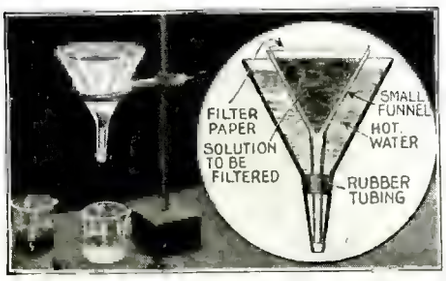
Here is a scheme which was used for increasing my water supply after the pipes had become choked and caked with rust, which saved the cost of having the street opened and new water pipes installed. It can be made very easily and then may be reserved for such purposes. I used a ¾-inch pipe, 6 inches long, threaded on one end, and made a plunger of hard wood, as per sketch herewith. In order to operate it, the water is first turned off, and the pipe disconnected at an elbow, "D." The 6-inch length of pipe "B" is then connected, and the plunger "A" inserted. This plunger should fit into the pipe snugly but not too tightly. Now hold the plunger down and turn the valve on fully. The water pressure will force the plunger up, and as it rises, drive it back sharply with a hammer or hatchet. Repeat this operation several times. Then turn off the water. The plunger is now removed and the water turned on. You will immediately note the increased pressure and the rust and dirt that comes out of the pipe, cleaned by the hammering of the plunger and vibrating both the pipes and the column of water. Should a pipe become stopped up screw on a 6-inch nipple "B"; fill entirely full of water, and insert plunger about a half inch, and proceed as before.

Contributed by W. T. MARKOWSKI.

THIS MONTH'S $5.00 PRIZE

HOW TO FILTER DIFFICULTLY SOLUBLE COMPOUNDS

When a substance has been dissolved, the solutions must often be filtered to remove insoluble impurities. This is usually accomplished with the aid of filter paper. But when the solution easily crystallizes when cold, it must be filtered through a hot funnel and the same case occurs when the compound is difficultly soluble. Then the



Certain solutions crystallize easily when cold. Consequently the above method if employed, will be found to aid rapid filtering by keeping the solution to be filtered warm.

spaces between filter and funnel are liable to become filled with crystals produced by the cold walls of the funnel.

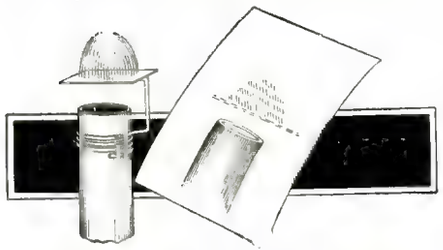
Very small quantities may easily be filtered by first warming the funnel, while larger quantities are readily filtered with the aid of a simple hot water filter. This consists of a large funnel about 5 or 6 inches in diameter with a comparatively short and wide stem. Into this a smaller funnel, also with a short but narrower stem is inserted. To the stem of the smaller one a short piece of rubber tubing is attached in such a way that the rubber will make a water-tight connection with the larger stem of the large funnel.

This double funnel is now warmed and boiling water then poured into the larger one. The hot water will keep the smaller funnel sufficiently warm for the filtration and the substance will not crystallize out during the process.

Contributed by DR. E. BADE

INTERFERENCE BANDS

This striking experiment requires the simplest of apparatus, merely a flame and a thin sheet of mica being sufficient. The best source of illumination is a Bunsen flame arranged with a small wire-gauze tray above. Monochromatic light is desirable so the tray is covered with sodium chloride



By means of a piece of mica and a Bunsen burner, striking demonstrations of the propagation of light in the form of waves, is made.

(common salt) and the burner adjusted to give its hottest flame. The sodium constituent in burning gives out a yellow light of that color only. The apparatus is arranged as shown, the mica being slightly bent back. After a little adjusting the image of the flame will be observed on the mica and it will consist of a number of parallel bands as if a ladder-like screen were interposed between the flame and mica.

The explanation of this phenomenon is that the form of light propagation is in waves. It follows thus, that when two light rays originally from the flame come together after separation, in certain positions the crests and troughs of one ray coincide with the crests and troughs of the other, the consequence being that the image is greatly intensified at these parts. In all other parts the crests and troughs of the one coincide with the respective troughs and crests of the other ray—there is therefore no image at these places. The two interfering light waves are reflected from the front and back faces respectively of the mica. The latter wave is therefore behind the former by amounts which vary according to the angle at which the initial ray strikes the surface and according to the thickness of the mica sheet.

Contributed by W. A. REID.

THE PHANTOM LUMP OF SUGAR

Dip a lump of sugar in some photographers' collodion till it absorbs all it can hold. Now let it dry about four hours to permit the ether to evaporate. The lump of sugar looks the same as any other lump. Put it in a glass of water and it will sink to the bottom as any other lump would. However, after a few minutes the sugar will apparently float to the surface of the water and stay there. Upon close inspection it will be seen that it is not the lump of sugar, but the collodion that filled the pores of the lump of sugar and then rose to the top when the sugar dissolved in the water. It is very fragile and breaks at a touch.

Contributed by PAUL MISTIK.

REMOVING FIXED STOPPERS

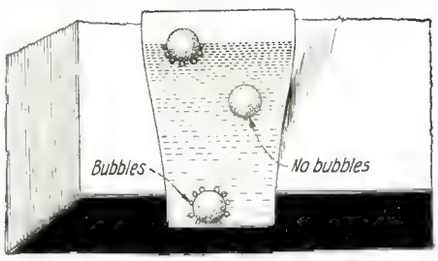
A very common thing with bottles containing chemicals used in laboratories is for the stopper to become fixed. Sometimes this may be removed by rocking the stopper backwards and forwards but where it is tightly fixed the top of the bottle may break. A far better way is to freeze the stopper so that it contracts and it will then easily be removed. Mix up some crushed ice and calcium chloride and then in this place the top of the stopper. Take care that the neck of the bottle does not touch the ice. Leave for about twenty minutes and then lift the bottle up holding the stopper in place. It will be found quite easy to remove the stopper which has shrunk under the extreme cold. One bottle which contained sodium carbonate had a stopper which defied all previous attempts to get it out. This was owing to the fact that the chemical had formed sodium silicate which is a first-class adhesive where glass is concerned. Yet, after freezing, the stopper was quite easily removed.

Contributed by S. LEONARD BASTIN.

THE MYSTERIOUS MOTH BALLS

Much fun and entertainment can be derived from two or three moth balls and a glass filled with water charged with sodium bicarbonate.

Drop the balls into the liquid. They immediately fall to the bottom, but soon, to the amazement of the onlookers, they slowly rise to the surface. Then, without warning, they sink again, repeating the process as long as any of the carbonate remains in the water. While at a distance the trick appears very mysterious and interesting, the phenomenon is simple and may later be explained. Just as soon as the balls have settled to the bottom, bubbles begin to form on their sides, growing rapidly larger, until their buoyancy overcomes the weight of the ball itself. Then they lift it to the surface, where some of the bubbles burst, causing



Ordinary moth balls when dropped into water charged with sodium bicarbonate, rise to the surface and sink again in a very mysterious manner.

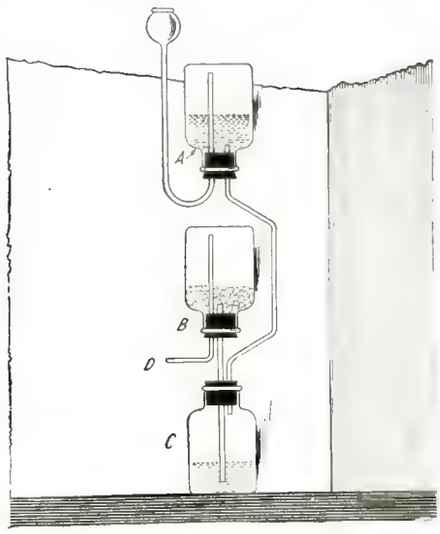
it to fall again. By placing several of the moth balls in the solution at one time, they appear to be moving up and down constantly.

Contributed by DALE R. VAN HORN.

A CONSTANT-PRESSURE GAS GENERATOR

Three bottles, A, B, C, with rubber stoppers and connecting with glass tubes as shown in the sketch are fitted together. In bottle *B* the solid chemicals are placed. Into bottle *A*, through the funnel, the acid is poured, the acid then runs down into the bottle *C*, when the acid rises from the bottle *C* and comes in contact with the chemicals in bottle *B* the gas is generated. The gas continues to generate until the pressure is sufficient to force the acid back down the tube into the bottle *C*, then the action ceases, but when the gas is used from the tube *D* the acid rises and more gas is generated, thus keeping the pressure nearly constant.

Contributed by WM. LINDEMAN.

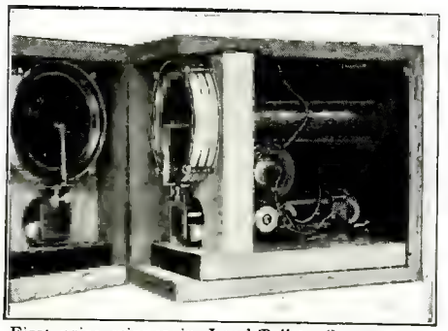


With the above apparatus gas can be generated at a constant pressure. Three bottles and as many two holed stoppers, with a few pieces of bent glass tubing, constitute the entire apparatus.

RADIO DEPARTMENT

Winners of $100.00 Prize Contest

"HOME-MADE LOUD-TALKERS"



First prize winner in Loud-Talker Contest, entered by Mr. Kraemer. A mirror was used to show the end view more clearly, there being but one phonograph sound box and magnet, as shown in diagram at right.

PRIZE WINNERS

FIRST PRIZE
$50.00 in gold, Mr. G. I. Kraemer, 212 West 72nd St., New York City.

SECOND PRIZE
$20.00 in gold, Mr. E. Carnutt, Garnett, Kansas.

THIRD PRIZE
$15.00 in gold, Mr. H. L. Jones, Saratoga Springs, N. Y.

FOURTH PRIZE
$10.00 in gold, Mr. Le Roy Western, 626 E. 2nd St., Plainfield, N. J.

FIFTH PRIZE
$5.00 in gold, Mr. T. Mackie, 36 Lowther Ave., Toronto, Canada.

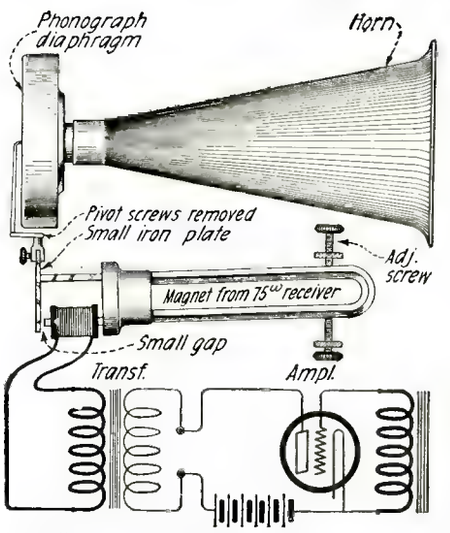
FIRST PRIZE

By G. I. Kraemer

THE accompanying diagram and photograph shows a type of loud-speaker which may be built by any amateur having a little experience with tools and enough patience to assemble it. It consists mainly of a phonograph sound-box, upon which is fixed a small piece of iron in place of the needle. In order to maintain this small plate firmly, the needle support is cut with a hacksaw to provide a slot into which the small plate fits and is soldered. The electrical part of it consists of a magnet taken from an old 75 ohm telephone receiver with one of the coils wound with some number 34 wire; the whole winding having a resistance of about 15 ohms. The mounting of these two units is clearly shown in the diagrams, and needs no further explanation.

Since this loud speaker is to be used with an amplifier, it is necessary to use a step-down transformer, the primary of which has an impedance equal to that of a vacuum tube. It will be necessary to experiment in order to get the exact winding. The secondary is wound with some number 34 enameled wire and has a resistance of about 20 ohms. The core is composed of a bundle of iron wires ⅜ of an inch in diameter by 2¼ inches long.

The only adjustments to be made once these parts are assembled is the distance between one of the pole pieces of the magnet and the small iron plate mounted upon the diaphragm. Once the proper adjustment is made the magnet may be secured in place by means of a small block of wood inserted under it, and held there by a screw. It should be noted that in order to allow a free vibration of the armature and diaphragm, the two supporting screws which



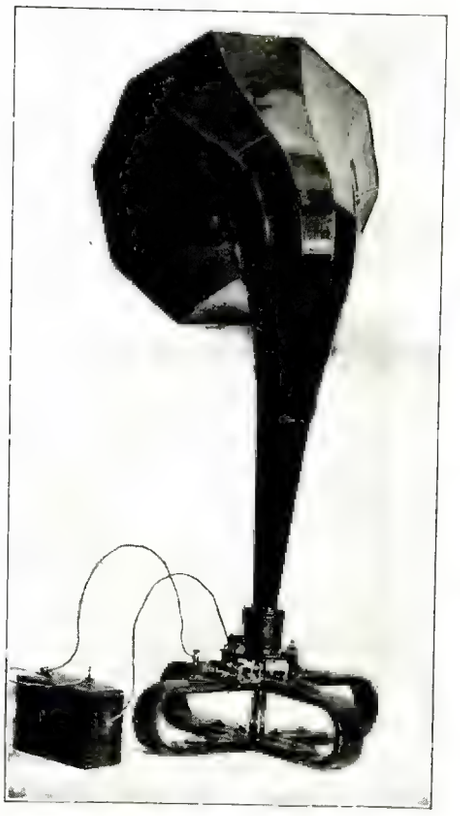
normally hold the needle clamp in place are removed, the only support being provided by the second pole piece of the magnet to which it adheres by magnetic attraction.

SECOND PRIZE

By E. Carnutt

Material Necessary

12 stove bolts 3/16 x ¾ of an inch, flat head.
1 phonograph horn.
4 stove bolts 3/16 x 1½ inches, round head.
1 stove bolt ⅛ x ½ of an inch round head.
1 carriage bolt ⅜ x 3¼ inches.
4 magnets from old magneto.
1 Ford spark coil.



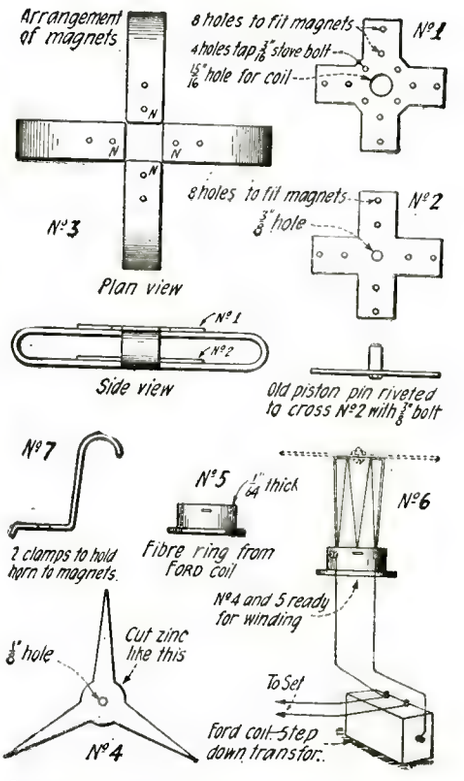
Piston pin ¾ x 3 inches.
Part of old disc phonograph record.
Scrap of zinc 3½ x 3½ inches.
Auto horn with diaphragm about 4½ inches in diameter.
2 pieces of iron 6½ × 6½ × 3/16 inches thick.
33 feet of No. 36 enameled wire.

Procedure

The main frame consists of two crosses, No. 1 and No. 2 in diagram, made from two 6½ x 6½ x 3/16 inch pieces of sheet iron. Four holes are drilled and tapped to receive the four 1½ × 3/16 inch stove bolts so that the horn and diaphragm can be adjusted. One 15/16 inch hole is drilled in the center to receive the coil mounting. Eight holes are drilled to match holes in the magnets to receive the 3/16 × ¾ of an inch stove bolts.

No. 2 has 8 holes drilled in it to match those in the magnets and a ⅜ of an inch hole in the center in which is inserted a ⅜ of an inch bolt 3¼ inches long which passes through the hollow piston pin and is riveted fast to the same. This forms the south pole of the four magnets and the 15/16 of an inch hole in No. 1 forms the north pole.

The four magnets and the two crosses are assembled, the piston pin from the south pole to be in the center of the 15/16 inch hole in No. 1 when assembled. The four magnets are arranged as in No. 3.



Second prize winner in our Loud-Talker Contest, entered by Mr. Carnutt, who submitted affidavits as to the excellent talking qualities of his loud-talker. Details of the magnets and moving coil arrangement are given in diagram at right.

No. 2 is bolted on the bottom, inside, and cross No. 1 is bolted on the top, outside, using the 3/16 x ¾ of an inch stove bolts.

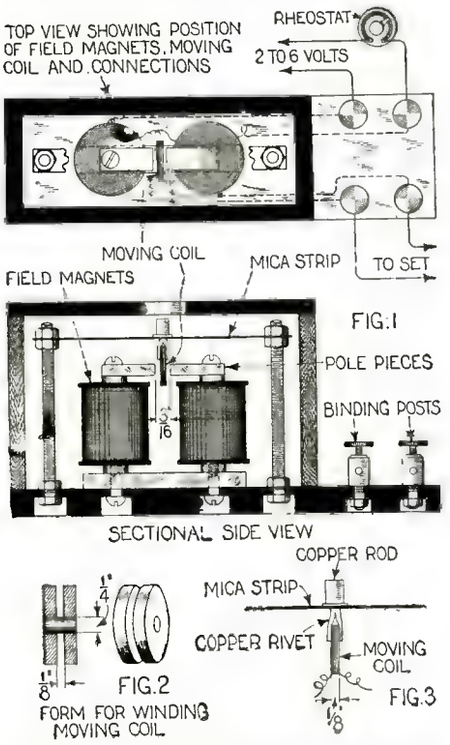
Dismantle the auto horn, remove all the works, and cut out with a chisel in the under plate that held the diaphragm, a hole about 2 inches in diameter. Cut from the old phonograph record a disc small enough to fit inside of the screws and to take the place of the old diaphragm. Bore a ⅛ inch hole in the center.

Take a block of wood as large as the disc, drive a brad in the center and place the disc on this and rub on sandpaper until disc is as thin as No. 20 gauge iron. Put this in place of the old diaphragm and reassemble the horn.

A three-legged clip is made as shown in No. 4 to hold the moving coil against the diaphragm.

Take off the vibrator from the Ford coil, lift the small fiber ring that surrounds the wire core, put back the vibrator and screw the points down tight. This coil will be the step-down transformer for the loud-talker.

File the fiber ring as in No. 5 and with



Details of the fourth prize winner in Loud-talker Contest are given in drawings above. This instrument is intended for use in connection with a phonograph, the needle of the reproducer resting on the copper rod fastened to the mica strip.

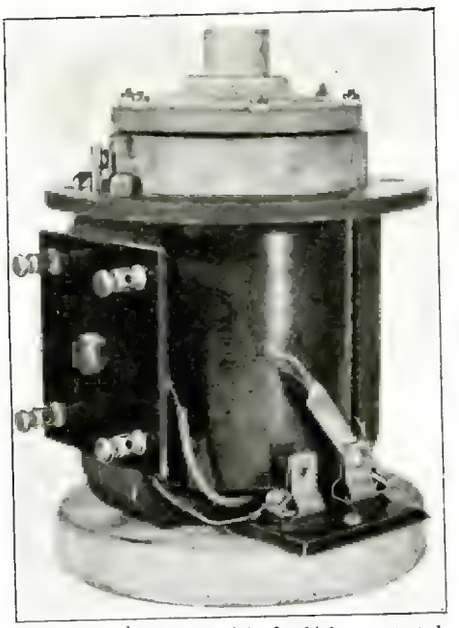
point of a knife make three little slots to receive the points of No. 4. File the inside of the ring to fit loosely over the piston pin. After No. 4 and 5 are assembled as in No. 6, wind on 33 feet of No. 36 enameled wire and shellac, leaving about 6 inches for leads which are attached to the binding posts.

After No. 6 has been wound it is fastened to the diaphragm with the ⅛ x ½ inch stove bolt and the auto horn and coil are set on the four 1½ x 3/16 inch bolts and the coil is slipped over the piston pin. Then the phonograph horn is fastened to the auto horn with the two clamps. No. 7.

The moving coil is adjusted so that the top of the wire of the winding is just a little higher than the top of the piston pin.

The loud speaker may be hung on the wall and a straight phonograph horn used, or it may be set on the table and used as shown in the photograph.

This will make a loud-talker that is almost as loud as a commercial one and requires no battery. With a two-step amplifier, the signals can be heard across the street very plainly.



Loud-talker design, model of which was tested in Radio News Laboratories, as built by Mr. H. L. Jones, third prize winner. All details are given in the text and accompanying drawing at the right.

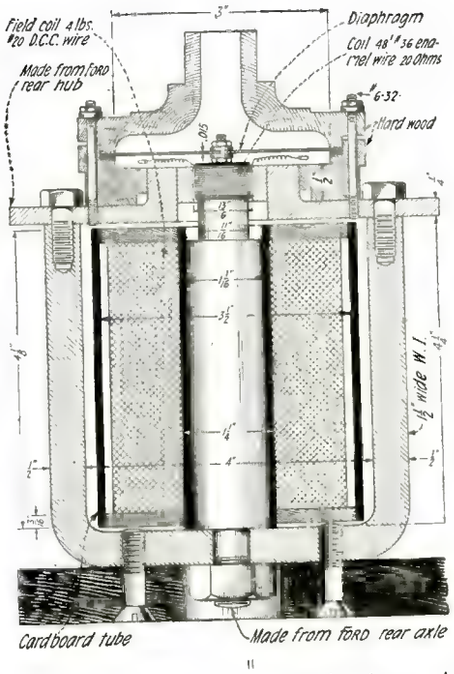
THIRD PRIZE

By H. L. Jones

This loud-talker, built on the style of a Magnavox, with a single pole and a field coil taking one-half ampere at 6 volts, is very easily built from odd parts and with very few tools.

The core of the field magnet is made from a section of a Ford rear axle and is wound with 4 pounds of No. 20 D.C.C. wire. Fibre ends 3/16 of an inch thick are provided for the core as shown. A "U" shaped bar of wrought iron, with the dimensions as shown, is used as the supporting medium. The lower end of the core is fastened thereto, and a ring, made from a Ford rear hub is attached to the top by means of two machine screws. Two pieces are turned up from hard wood as shown, to be used for holding the diaphragm. The latter is composed of sheet aluminum .015 of an inch thick, and to the center is fastened a brass tube 23/32 of an inch inside diameter by ½ of an inch long, by means of a small brass machine screw. The walls of this tube are .010 of an inch thick. This tube is wound with 48 feet of No. 36 enameled wire and leads are brought out therefrom to be connected to the secondary of the step-down transformer. Before assembling, a cardboard tube is slipped over the field winding for protection. The entire unit is mounted upon a piece of hard rubber which

Fifth prize winner in the Loud-talker Contest. This loud-speaker is built almost entirely from a Ford automobile horn, a moving coil being fastened to the diaphragm in the manner shown.



in turn is mounted on a wooden base. A single pole, single throw switch is also mounted on the hard rubber. This switch is connected in series with the field winding.

Another panel of hard rubber or other insulating composition is mounted on the front of one leg of the permanent magnet, and four binding posts attached thereto to provide connections.

A Ford coil was used for the step-down transformer, the secondary being connected to the receiving set, and the primary to the moving coil.

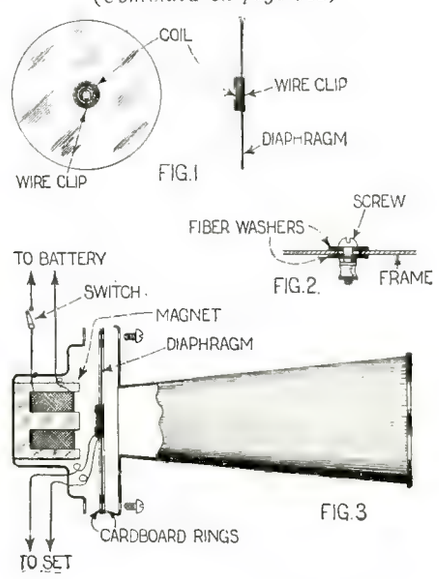
Applying 6 volts to the field, only .46 of an ampere will be drawn, which allows the use of the same storage battery that supplies the filament current. The apparatus has been built and works very well, and it will well repay any amateur to construct it.

FOURTH PRIZE

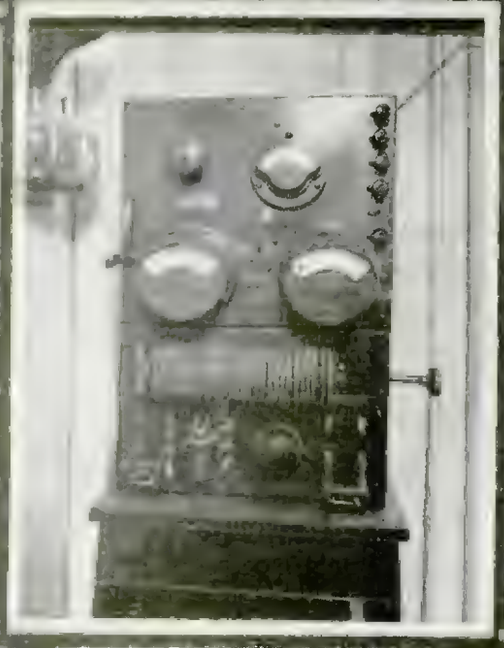
By Le Roy Western

Many amateurs, after having built a workable loud-talker, spoil the whole thing by using it in connection with a poorly designed horn and diaphragm, because they have no facilities for obtaining or making them properly. If they would only stop for a moment and think of the time and money spent by phonograph companies in designing their horns and reproducers, there might be more of them who would make use of these parts for this work. The loud-talker

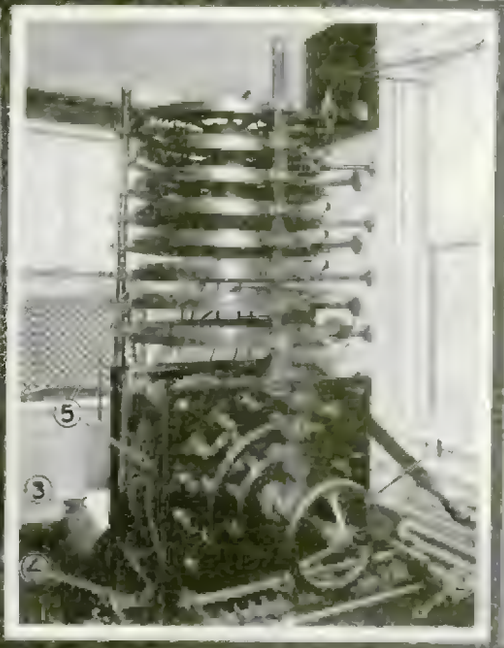
(*Continued on page* 912)



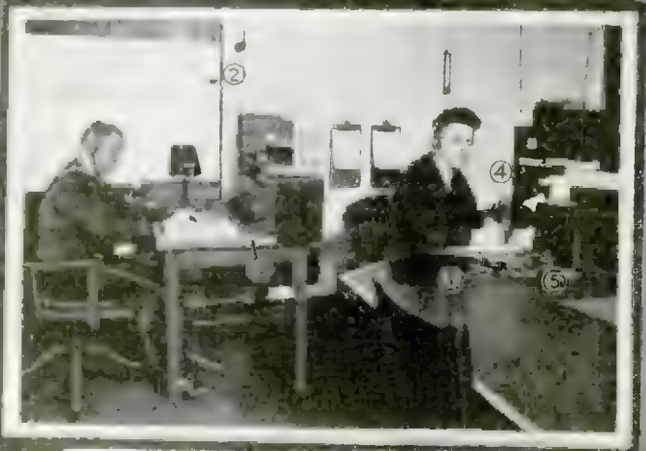
BROOKLYN NAVY YARD



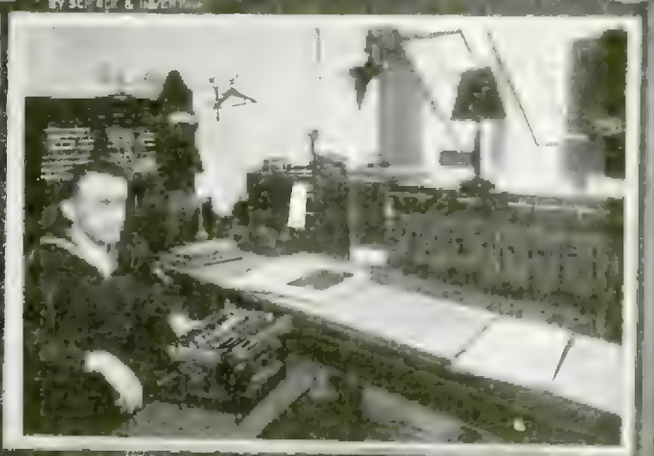
A very compact and powerful spark transmitter is shown above. It is rated at ½ K. W., and is used for experimental purposes as well as communication with air-craft.



In the above photo, 1 indicates the wave changing switch 2 the quenched gap 3 the transformers, 4 the condensers and 5 the oscillation transformers.



A view of one corner of the operating room is shown above. 1 indicates the keys used to control the transmitter shown in the upper right hand corner, 2 the compass chart, 3 the keys communicating with the compass stations, and 4 and 5 receiving sets tuned to 900 and 600 meters respectively.



In the left background of the above photo may be seen the switchboard connecting with various points along the Atlantic coast. On the right hand side of the picture are the relays and keys used in connection with these lines.

The large 11-wire antenna shown herewith is used for transmission, while the shorter 4-wire one is used for reception. The "cage" aerial is used for experimental purposes. These antennae are located in the Navy Yard at Brooklyn.

The receiving set situated in the transmitter room is shown herewith. The motor-generators are controlled by a switch on the lower left hand corner of the table. The wheel controlling the wave changing switch can be seen at the left hand side of the photo.

Operation of a Naval Radio Station

By A. P. PECK

MANY amateurs listening in on 600 meters and higher, and hearing the high-pitched note of a spark transmitter, do not realize the efficiency and dispatch with which messages are handled by the naval stations. Those who have some of the cheaper receiving sets are greatly annoyed at times by the naval stations when they are listening to broadcasting on 360 meters wave length. This, of course, is due to the broadness of tuning in their receiving set, and is not due to any discrepancy on the part of the transmitting station. When a radiophone "bug" is listening-in to the programme of a broadcasting station, and hears a fairly high-pitched note come roaring in, he should not start to berate the city, the state, the country and the world in general for this interference, but should go at once to the heart of the trouble, and install a selective receiver or tuner.

The naval station which we take as our model, is located in New York City. Its call letters are NAH, and it is the standby of old-time radio-telegraph fans when they wish to practice a little by copying navy messages. In the years before the war, which may very aptly be termed, in radio language, the years before broadcasting, the messages transmitted from NAH and similar stations, were practically the only ones the radio bug could listen to. We therefore find among those who know, a sincere respect for the operators of these stations.

When one enters the operating room of NAH, which is located on South St., New York City, his first impression is that he has got into the *wrong room*, as the sounds of many telegraph sounders and relays are heard. However, he then sees two operators sitting at desks with the "cans" (receivers) on, and becomes reassured.

Besides many other duties, the operators at NAH also have to chart the location of ships, the bearings of which are sent to them by the various compass stations along the coast of the third naval district.

As seen in one of the accompanying photographs, an operator sits at a desk with several telegraph keys and relays in front of him. To his left is a telegraph sounder, and on the wall beside him is a large map with the compass stations marked thereon. In the third district these stations are located at Manasquan, Sandy Hook, Fire Island, and Amagansett, the first being the furthest south, and the last the furthest north.

When a ship at sea wants to obtain a very correct bearing on her position, the ship's operator sends out his call letters, repeating them for 50 seconds. In sending these out, he prolongs all the dashes in his call, or if the call does not include any dashes, he prolongs all the dots. This is the new regulation for obtaining bearings, the old one being that the ship was to send out the letters MO for a specified length of time followed by its call letters. This, however, caused much confusion at the compass stations, and therefore the latter method has been substituted. Now at the various compass stations along the coast, this prolonged call is heard, and the operators swing their loops until they locate the exact direction in which the ship is located from their particular station. The direction is noted, and is sent by land wire telegraph to Brooklyn Navy Yard, where the operator receives it and notes it down. The operator at NAH has also been listening in for these *compass calls* on his own receiver, so that he will be ready to get the bearings from the compass stations. These he soon obtains. The operator then repeats this information back to the compass station for verification. This process is gone through with all four of the above-mentioned compass stations, and then the operator at NAH plots the position of the ship on a chart. The triangulation method is used; four stations being used for more accurate results. Next by means of one of the telegraph keys located on his desk, he signals to the station at Fire Island that he is ready to transmit. The operator at Fire Island starts his motor-generators, and the operator at NAH sends out the location of the ship by means of Fire Island's transmitter. His telegraph key closes a relay at the Fire Island station, which in turn closes the primary circuit of the transformers, or, in radio terms, the transmitter at Fire Island is remotely controlled from NAH.

Many ships avail themselves of this compass service, as it forms a very accurate check on their own observation bearings. It is very easy to see therefore, that the operators are at times kept extremely busy.

At another desk in the operating room, an operator sits with a pair of receivers on, one of which is connected to a set tuned to 600 meters, and the other to another set which is tuned to 975. These sets are of the standard navy type, employing a detector and two stages of audio-frequency amplification. The tubes used are Signal Corps type V. T. I's throughout. Literally speaking, he listens with one ear to commercial traffic, and with the other to naval traffic. His work is to handle any commercial business between ship and shore and between naval vessels and naval headquarters, which may be intended for his station. When he hears NAH being called, he signals to the transmitting station, which is located in Brooklyn, and will be described more in detail later, that he wishes to transmit. He also tells the operator at the transmitting station, what wave he wishes to use. He then gets the message from the ship, and answers it or forwards it as the requirements may be. All his transmitting is done with one of two ordinary telegraph keys, one of which controls a 5 K.W. transmitter, and the other, a ½ K.W. transmitter. His receiving is done over an aerial placed on the top of the building in which the operating room is located.

In still another part of the operating room there is a switchboard similar to a regular telephone board. This board connects with telegraph lines extending to various points from Washington, D. C. to Maine. In connection with this board there are several relays and keys which are used for transmitting naval business by land telegraph. When a radio message comes in that is to be delivered by land line to some point, the line is selected on the switch board, and the message sent by regular telegraphy. This is an everyday part of the operator's duty and it is therefore necessary for him to be able to read both Morse and Continental.

As before stated, the transmitting apparatus proper of NAH is located in Brooklyn at the navy yard. Hence, the common name for this station, Brooklyn Navy Yard. In the transmitting room, there is a desk at which is located a receiving set similar to those found in the operating room, which is used for various general utility purposes.

On a large panel to the left of the operator's table, is located the transmitting apparatus, together with the wave-changing switch. The wave-changing switch throws into or out of the circuit various combinations of inductances and capacities.. For instance, for 600 meter transmission, the condensers are in series and a certain amount of inductance is in circuit, while for 800 the compass wave length and higher waves the condensers are in parallel, and various other predetermined amounts of inductance are used. This transmitting set has a power of 5 K.W., and is capable of working on 600, 800, 975 and 1832 meters. The latter is the working wave of this station for general, commercial and naval traffic.

There are ten pancake type inductance coils used in this transmitter. The condensers are of the commercial mica type, and the gap is a series of quenched gaps.

On another panel is located a ½ K.W. transmitter, which operates on 507 meters, and is used for communication with air-craft.

The current for both of these sets is obtained from a motor-generator outfit located in another room.

The transmitting antennæ are shown in an accompanying photograph. There is a large one which is about 250 feet long, of the "T" type, composed of 11 wires. This is used for all work above 600 meters. There is also a small aerial of the inverted "L" type composed of 4 wires, each about 100 feet long. This is for all short wave work. Several experiments have been made with a cage type antenna but this is not being used at the present time.

There is a complete squad of operators on duty day and night, and it is easily seen that our navy is well up-to-date in radio work, and handles traffic in the most up-to-date manner.

Some people may think that the life of a "gob" is an easy one, but if they would visit the operating room of Brooklyn Navy Yard, they would speedily become convinced that such is by no means the case. At times when the Atlantic fleet is in the harbor at New York, or on the Hudson River, the operators are continually transmitting and receiving for the entire length of their shift. At such periods, all the business between the ships and headquarters is handled by this station, and when the entire fleet is in, the volume of traffic can be readily imagined.

During periods of storms at sea, the compass stations are always over-taxed by ships desiring to know their bearings in order to avoid wrecks. At these times, the operator at Brooklyn Navy Yard who charts the positions, has his hands full, as it is up to him to receive the positions from the various stations along the coast, lay them out on the chart, compute the position of the ship, and then by means of Fire Island's transmitter, inform the ship as to its exact position.

This is one of the greatest services that radio gives to the sea, rivalling almost the Radio Doctor which has recently been put into service, whereby ships are able to get medical advice by radio when they do not carry a competent physician.

Features in January "Radio News"

Dr. Lee de Forest Speaks. An Interview with the inventor. **By H. Winfield Secor.**

Static Is Greatest Obstacle in Radio. An interview with Dr. L. W. Austin, Head of the Naval Radio Research Laboratory. **By S. R. Winters.**

Mr. Murchison's Radio Party. **By Ellis Parker Butler, author of "Pigs Is Pigs."**

Use of High Power Vacuum Tubes. **By Dr. Irving Langmuir.**

Radio Headsets. **By Jesse Marsten.**

How Market Reports Are Made. **By J. Farrell**

The New Schmidt High Frequency Alternator. The rival of the vacuum tube. **By Dr. K. Wirtz.**

Radio Wrinkles for Those Who Build Their Own

By A. P. PECK

WHO ever heard of a radio "ham" who was not in the height of his glory when constructing some part of his set or improving it in some way? For just this type of radio man, the following suggestions are given, and if anyone reading this article has not tried "building his own," let him, or her, for that matter, start right now, and try some of these things. He, or she, will then find that there is greater enjoyment in store than just that of listening to the various concerts.

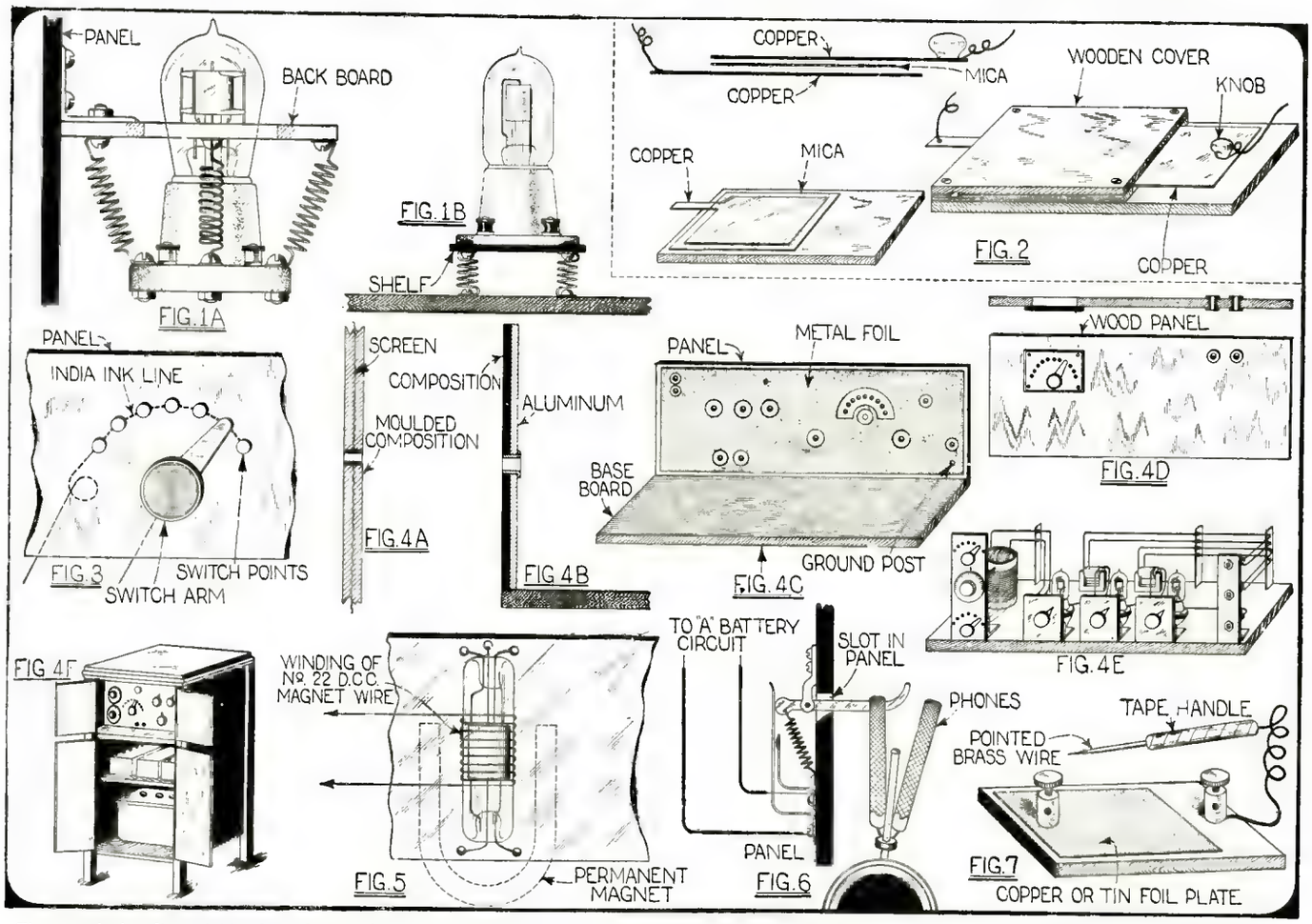
When listening in with an audion set tuned to its greatest sensitiveness, you may have often noticed that every tap on the table, or in some cases, even a person walking across the floor of the room, causes noises to be heard in the phones. This is due to the jarring of the tubes, and can be greatly reduced, if not eliminated, by either of the methods shown in Fig 1. In Fig 1A the socket is suspended by springs from a board placed in the rear of the panel and at right angles to it. A large hole is cut in this board of sufficient size to allow the tube to slip readily through it. Four fairly stiff wire springs are then obtained, and the socket is suspended just below the hole by means of them. Many ways of fastening these suspending springs will suggest themselves to the builder. For instance, small eyes may be turned in each end of the wire, and fastened to the backboard by means of wood screws, and to the socket by means of machine screws.

In Fig. 1B another method is shown which may be used in either cabinet sets, or in sets where the instruments are used as isolated units placed upon a table. In this case, the springs should consist of five or six turns of No. 10 or No. 12 brass wire; the convolutions to be about the size of a lead pencil in diameter. The same method of fastening the springs may be used here as in 1A.

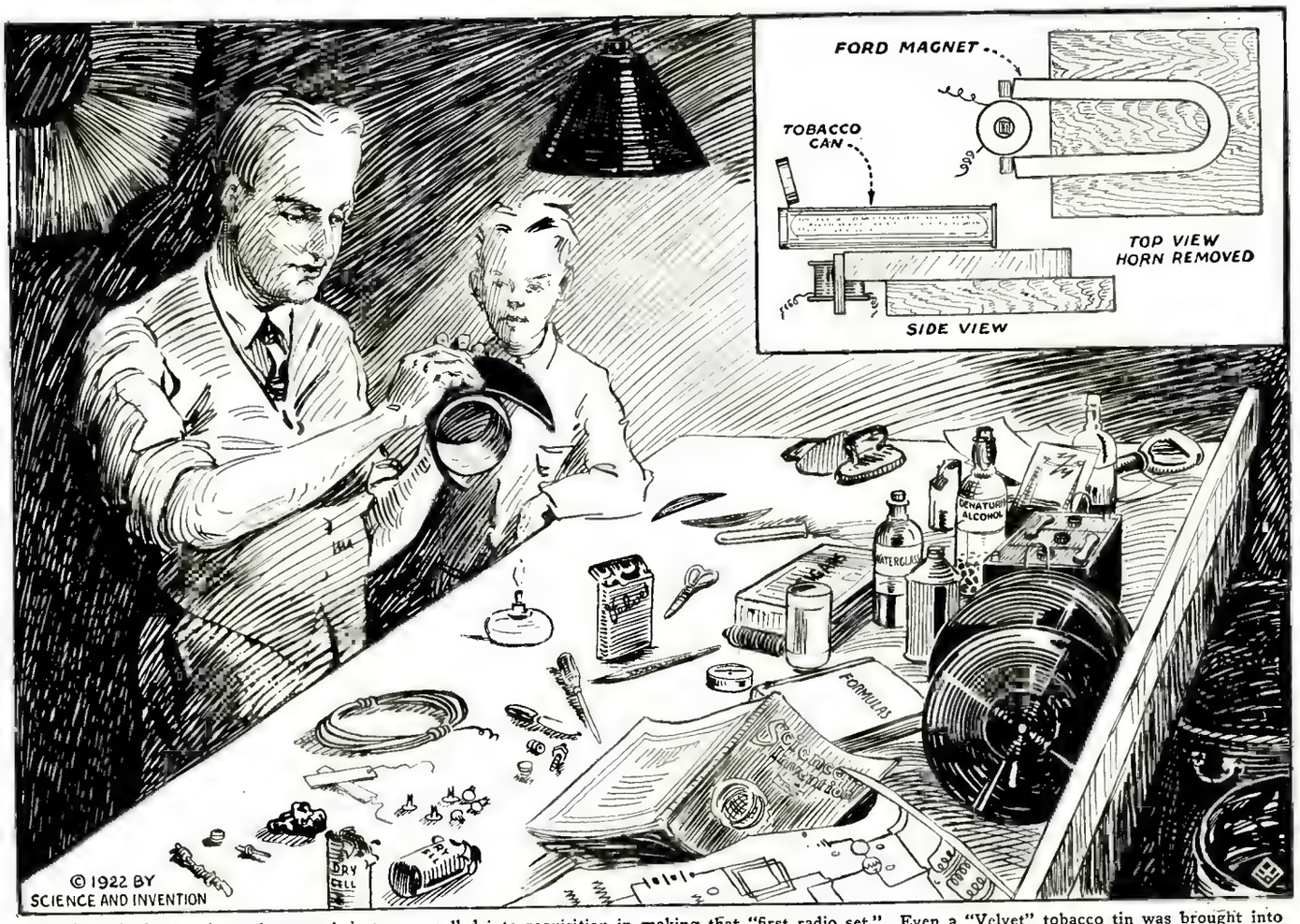
Very little attention is paid by the average amateur to his grid condenser and grid leak. Generally he buys them ready made, connects them in the circuit, and lets it go at that. Some times he obtains good results, but in most cases, much better results could be secured by having both of these units variable. A very simple variable grid condenser may be made as shown in Fig. 2. Two strips of cigar box wood are obtained about 2 inches wide; one of them to be 2 inches long, and the other about 3½ to 4 inches long. The longer one is used for the base, and on it is laid a copper sheet about 1¼ inches square with a lug extending from one side of it as shown in the drawing. This piece should be fastened to the base by means of shellac or glue. Over this and fastened to it by shellac, is placed a strip of mica about 1½ inches square. Another strip of copper 1¼ inches wide, and about 2¼ inches long is obtained, and a knob is fastened to one end of it. This is placed over the mica sheet but is not fastened in any way. The second piece of cigar box wood is placed over all these, with a strip of cardboard about ⅛ inch wide placed around the edge in order to separate the two wooden strips. This is done so that the top copper sheet may slide easily. The wooden cover may be fastened either with small brads or shellac. The capacity of this condenser is varied by pulling the long copper strip out or pushing it in. This condenser is very advantageous as the characteristics of various tubes require slightly different capacities for best operation.

As said before, a variable grid leak can always be used to advantage, and the construction of a very simple one is shown in Fig. 3. Six holes are drilled in the panel in the form of a semi-circle, whose radius is equal to that of the switch arm to be used. On the back of the panel draw fairly heavy lines in India ink, connecting the edges of these holes as shown. Now insert switch points in these holes, and fasten the nuts on the back. It will be noticed that each nut will make contact with two ink lines. The switch points should be placed about ½ inch apart. A hole is now drilled for the switch arm, and connections are made to the first switch point and the arm. This variable grid leak may be used either in parallel with the above described grid condenser, or may

(Continued on page 921)



The practical radio wrinkles here described by the author, will no doubt prove of extreme interest to all radio fans, particularly those who are building their own sets. Fig. 1 shows two methods of suspending the audion receptacles on springs to absorb vibration; Fig. 2 shows a simple variable grid condenser; Fig. 3 shows how to make your own adjustable grid leak; Fig. 4, methods of shielding panel; Fig. 4-F, pleasing design of radio receiving set cabinet resembling a victrola; Fig. 5, using electro-magnet coil around tubular audion, or else steel magnet to enhance efficiency; Fig. 6 shows automatic "A" battery switch operated by phones; Fig. 7 shows quick testing device for crystals.



All of the junk that the author was heir to was called into requisition in making that "first radio set." Even a "Velvet" tobacco tin was brought into play in improvising a loud-speaker, a detail view of which is shown in the upper right-hand corner. This loud-speaker is sure a gem. All you need is an old magneto magnet, a small E-shaped iron core with a coil of wire wound on the center leg, and the aforesaid Velvet tobacco tin. It sure is the cat's meow. How did it talk? Well, read the story.

That First Radio Set

WITH THE "VELVET" LOUD SPEAKER

By MIKE R. FARRODS

A LITTLE over a year ago I sent my first two bits for a big catalogue and encyclopedia of radio. Several more advertisers of catalogues induced me to part with real money before I realized that there were not enough presses in the United States to supply the demand for catalogues at 25 cents each. After I had received the third bulletin, and price list, I was able to explain to my ten-year-old the fundamental difference between a grid leak and a variometer. True, my mind was somewhat hazy as to their location in a hook-up, but it satisfied him and caused me to feel very grateful to the dealer who had inveigled me into investing in his stock of crisp new price lists.

It was about this period of my radio uplift that I conceived the idea of making my own for $25.00 putting the $75.00 that I would thereby save out at 8% interest, compounded semi-annually. It wasn't my own idea exactly. In fact, I had very limited ideas about this subject, Radio. The title of a book selling for 25c, "How to Build Your Own Radio Receiver," did it. I was about to send the "check enclosed," when I discovered on the newsdealer's stand a magazine entitled, SCIENCE AND INVENTION. Idly turning the pages, to my amazement, nearly two whole pages and a column stuck back among the ads, were devoted to the construction of "A Very Efficient Crystal Set." I bought the copy—and thereby hangs an antenna. I mailed an order at once to the catalog publisher who had ornamented his price list with two huge towers with lightning playing between them, stating I was in a hurry for spools of No. 24 D. S. C., galena tested and untested, phones 1,000 to 3,000 ohms, variable and invariable condensers, crystal detector stands and cat-whiskers.

After a week spent in reading and re-reading the instructions published in SCIENCE AND INVENTION, I found myself lingering until the last person had left the General Delivery window and departed from the little post office, that I might be sure the postmaster had not overlooked my package. Two weeks passed, then one day I received a letter. Same two towers, lightning and all. The notice read, *"Your order received. We are out of articles ordered. Will send as soon as new shipment is received."* Remember, this was during last spring's radio boom when radio goods were scarcer than hens' teeth.

A couple of weeks later, having heard nothing from the two towers, I decided to have the Ford brakes relined, "while you wait." The best mechanic had just clinched the last split rivet when I got my first real idea. "Are those things copper?" I asked. "Sure," he replied. "Why?" "Give me two dozen of them." "Twenty cents." While he finished his job, I went through his electrical junk box, and found some green silk covered wire, about a pound of it. I got it for two bits. I drove home and read the article over again. I collected an assortment of nuts, bolts and binding posts from a bunch of dry cells, and saved some of the cement or wax that capped them. Up in the attic I located about a dozen old disc phonograph records, and I started "that first set."

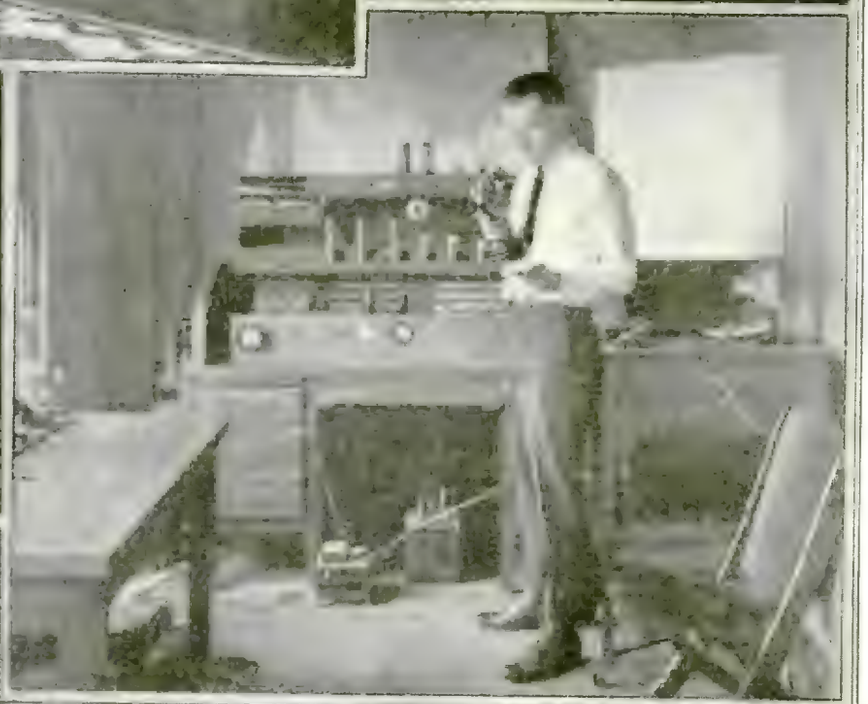
From a 12-inch record, I cut a piece 3½ inches wide and 12 inches long. I did this with a fine toothed saw, sawing straight across the record. I then warmed the strip until it was plastic, and wrapping a layer of paper around a baking powder can I bent the strip of record round this form, and cut through the lap with an old case knife, heated in the stove until the blade was quite hot. I then spread some of the wax from the battery tops over the joint, using the knife blade to force it into the joint. When it was cool, I sandpapered the joint, and slipped it off the can, and with the hot tang of a three-cornered file, I punched the holes to anchor the wire for beginning the primary coil. I finished winding as per directions in the magazine, and anchored the wire. Then I made the secondary tube in the same manner, using a smaller can for a form, and a narrower strip of record. Near the top of the primary coil I punched holes for the shaft of the secondary coil, and holes through the center of the secondary coil to receive this shaft, using the hot file in both cases. The shaft and knob were taken from a discarded

(*Continued on page 926*)

BROADCAST STATIONS

Station KYG, operated by Willard P. Hawley, Jr., Portland, Ore. broadcasts three times a week, on Tuesday, Thursday and Saturday evenings. With a power of 100 watts, they raciate five amperes on C.W., and 3.6 amperes on radiophone.

Station KDYS, of the Great Falls Tribune, Inc., Great Falls, Mont., broadcasts daily except Thursday, but including Sunday. Using two 50 watt power tubes with a radiation of 5.75 amperes they have been heard 4,700 miles away



Station KDZR, of the Bellingham Publishing Co., Bellingham, Wash., operates every evening, 7:15 to 8:45, Pacific Time. They furnish excellent entertainment to amateurs employing crystal receiving sets within a radius of 20 miles and have been heard 1,800 miles away

RADIO BROADCAST

THERE are so many broadcasting stations which have forwarded information, that we regret we have only space enough to print a very few. Those stations which have been courteous enough to submit photographs will find that the photos will be published in due time. The stations listed on this sheet will not be published in the next issue. We would suggest to our readers that the map locations indicated on this page are for the special supplement map given free with the May issue of SCIENCE AND INVENTION. At a great expense this list of the stations has been practically completed as far as commercial broadcasting stations are concerned. We will present our readers with additional information on the new stations as it is brought to our attention. Address all communications to Editor Radio Broadcast, c/o SCIENCE AND INVENTION MAGAZINE, New York City.

ADDITIONAL BROADCASTING STATIONS NOT PREVIOUSLY LISTED

Call Letters	Name	City and State	Wave Length	Map Location
KFBV	Clarence O. Ford	Colo. Springs, Colo.	360	P-20
KFCF	Frank A. Moore	Walla Walla, Wash.	360	E-9
KFCH	Electric Service Sta., Inc.	Billings, Mont.	360	G-18
KFDA	Adler's Music Store	Baker, Ore.	360	F-9
KFDD	St. Michaels Cathedral	Boise, Idaho	360	H-10
KFEB	City of Taft	Taft, Cal.	360	
KFEC	Meier & Frank Co.	Portland, Ore.	360	E-5
KFFE	Eastern Oregon Radio Co.	Pendleton, Ore.	360	E-9
WGM	Atlanta Constitution	Atlanta, Ga.	400	V-39
WMAU	Louisiana State Fair Assoc. (W. E. Antony.)	Shreveport, La.	360	X-30
WMAV	Alabama Polytechnic Inst.	Auburn, Ala.	360-485	W-38
WMAW	Wahpeton Electric Co.	Wahpeton, N. Dak.	360	G-27
WMAX	K & K Radio Supply Co.	Ann Arbor, Mich.	360	L-39
WMAY	Kingshighway Presbyterian Church	St. Louis, Mo.	360	Q-33
WMAZ	Mercer University	Macon, Ga.	360	W-40
WNAJ	Benson Co.	Chicago, Ill.	360	M-35
WNAK	Manhattan Radio Supply Co.	Manhattan, Kansas.	360	P-26
WNAM	Ideal Apparatus Co.	Evansville, Ind.	360	Q-36
WNAN	Syracuse Radio Telephone Co.	Syracuse, N. Y.	360	J-45
WNAP	Wittenberg College	Springfield, Ohio.	360	M-41
WNAR	C. O. Rhodes	Butler, Mo.	360	Q-29
WNAS	Texas Radio Corp. & Austin Statesman	Austin, Tex.	360	Z-25
WNAT	Lenning Brothers Co.	Philadelphia, Pa.	360	N-47
WOAB	Valley Radio	Grand Forks, N. D.	360	E-27
WOAC	Maus Radio Co.	Lima, Ohio	360	N-39
WOAD	Friday Battery & Elec. Corp.	Sigourney, Iowa.	360	N-31
WOAG	Apollo Theatre (Belvidere Amusement Co.)	Belvidere, Ill.	360	L-34
WOAV	Pennsylvania Nat. Guard.	Erie, Pa.	360	L-42
WPAA	Anderson & Webster Elec. Co.	Wahoo, Nebr.	360	N-27
WPAB	Pennsylvania State College.	State College, Pa.	360	M-44
WPAF	Peterson Radio Co.	Council Bluffs, Ia.	360	N-28
WQAA	Horace A. Beale, Jr.	Parkesburg, Pa.	360	N-46
WRAR	Jacob C. Thomas	David City, Nebr.	360	N-26
WSAS	State of Nebraska, Dept. of Agriculture	Lincoln, Nebr.	360-485	N-27
WSAV	Clifford W. Vick Radio Construction Co.	Houston, Tex.	360	AA-29
WTAW	Agricultural and Mechanical College	College Sta., Tex.	360	
WWAC	Sanger Bros.	Waco, Tex.	360	Y-26
WWAX	Wormser Bros.	Laredo, Tex.	360	AD-24

ELABORATED LIST GIVING TIME AND NATURE OF BROADCAST (Continued from previous issues)

WGL—Thos. F. Howlett, Philadelphia, Pa.—360
Weather, lectures, market and stock reports, music, baseball scores, news bulletins and special features Thursdays and Fridays 9.00-11.30 P. M. Maximum range 2,000 miles.

WGR—Federal Telephone & Telegraph, Buffalo, N. Y.—360-485
Weather, time signals, lectures, market and stock reports, music, baseball scores, news bulletins and special features daily 1.15, 5.30, 8.00-10.00 P. M. Consistent range 750 miles. Maximum 1,200. Eastern standard time.

WGV—Interstate Electric Co., New Orleans, La.—360
Weather, lectures, market reports, music, sermons, baseball scores, news bulletins and special features daily except Friday and Sunday, 7.00-7.30 P. M., 8.00-9.00 P. M. Friday 7.00-7.30 P. M,, Sunday 700-10.00 P. M.

WHAA—State University of Iowa, Iowa City, Iowa.—360
Lectures, music, vocal and instrumental talent, sermons, baseball scores, news bulletins and special features daily except Sundays, 8.00-8.30 P. M. Sunday 10.45-12.00 A. M. Consistent range 150 miles, maximum 750.

WHAC—Cole Bros. Electric Co., Waterloo, Iowa.—360
Lectures, vocal and instrumental talent, sermons baseball scores, news bulletins and special features Mondays, Wednesdays and Fridays 6.15 P. M. and 9.30 P. M. Tuesdays, Thursdays, Saturdays and Sundays 6.15 P. M. Consistent range 200 miles, maximum 600. Central Standard time.

WHAJ—Bluefield Daily Telegraph, Bluefield, W. Va.—360
Lectures, vocal and instrumental talent, sermons, baseball scores, news bulletins Mondays and Thursdays 7.45-9.00 P. M. Saturdays 4.00-5.30 P. M. Sundays 11.00 A. M. and 7.45 P. M. Consistent range 200 miles, maximum 600. Eastern Standard time.

WHAV—Wilmington Electrical Spec. Co., Inc. Wilmington, Del.—360
Weather, lectures, music, sermons, baseball scores, news bulletins and special features Mondays. Wednesdays and Fridays 6.00-8.00 P. M. Consistent range 50 miles, maximum 150.

WHAW—Pierce Electric Company, Tampa, Fla.—360
Weather, vocal and instrumental talent, and special features daily except Sunday 12.00-1.00 P. M., 4.00-5.00 P. M., 8.-00-10.00 P. M. Consistent range 50 miles, maximum 150.

WHAY—The Huntington Press, Huntington, Ind.—360-485
Weather, lectures, market reports, vocal and instrumental talent, sermons, baseball scores, news bulletins daily 7.00 P. M. Mondays, Wednesdays, Fridays, and Sundays 8.15 P. M. Consistent range 25 miles, maximum 100.

WHAZ—Rensselaer Polytechnic Inst., Troy, N. Y.—360
Lectures, music, baseball scores, news bulletins and special features, Mondays 8.15-9.30 P. M. Saturdays 10.00-11.00 A. M Consistent range 1,000 miles, maximum 3,000.

WHN—Ridgewood Times Ptg. & Pub. Co., Ridgewood, N. Y.—360
Weather, lectures, market reports, music, vocal and instrumental talent, sermons, news bulletins, morning and evening, physical culture exercises and special features daily except Sunday 7.30, 8.00, 8.30, and 9.15-11.00 A. M., 12.30-12.50 P. M., 2.15-2.30 P. M., 4.15-4.30 P. M. Daily 10.30 P. M. to midnight, often later. Sundays 9.15-10.30 A. M., 1.00-3.00 P. M., 10.30 P. M. to midnight

WHU—Wm. B. Duck Co., Toledo, Ohio.—360
Weather, lectures, market reports, vocal and instrumental talent, sermons and special features daily except Saturdays and Sundays 9.40 A. M., 12.30 P. M., and 1.40 P. M. Tuesdays and Thursdays 9.00 P. M. Saturdays 9.40 A. M. and 12.30 P. M. Consistent range 400 miles, maximum 500. Eastern standard time.

WIAC—Galveston Tribune, Galveston, Tex.—360
Weather, lectures, music and special features daily except Sunday 12.30 P. M. Tuesdays, Thursdays and Saturdays 7.45-9.00 P. M. Consistent range 100 miles, maximum 1,000.

WIAG—Matthews Electric Supply Co., Birmingham, Ala.—360
Weather, lectures, market reports, vocal and instrumental talent, sermons, baseball scores, news bulletins and special features daily except Sundays 3.30 P. M. Tuesdays, Thursdays, Saturdays and Sundays 8.00 P. M. Consistent range 500 miles, maximum 1,200. Central standard time.

(To be continued in the next issue—Save these as they will not be repeated.)

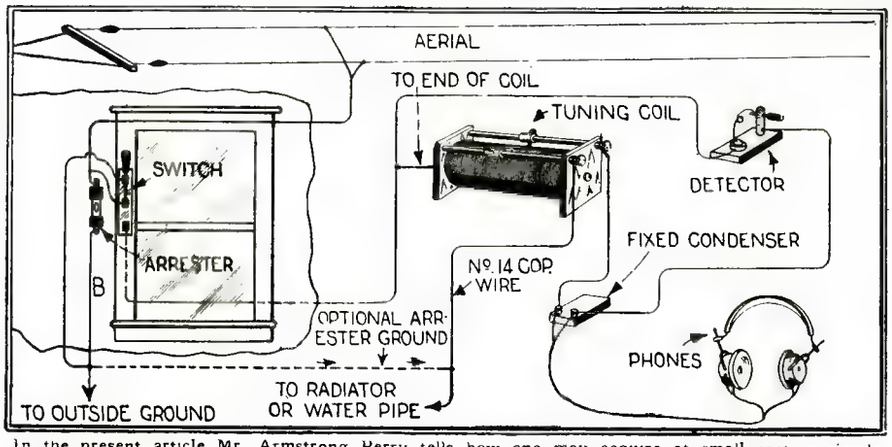
Radio for the Beginner

By ARMSTRONG PERRY

No. 11—HOW TO ACQUIRE A SIMPLE RECEIVING STATION

THERE is no longer an excuse for anyone to miss the joys of radio. I find in the shops complete receivers that sell as low as five dollars and that will work fairly well within a radius of five miles of a strong broadcasting station. Better yet, I find in the five-and-ten-cent stores and in shops that permit customers to be wildly extravagant and spend as much as a quarter at a time, diagrams and parts for assembling receiving outfits of various types.

Now I know the arguments that radio folks raise against five - and - ten - cent radio. They say that stuff sold at such prices must necessarily be cheap. Of course it is. They say it is inefficient. Comparatively speaking it may be. When I have the price I buy the best stuff I can find and not quarrel about the price. It is cheaper in the long run. But when I have only a nickel to spend and can get for that nickel something that I want, I do not growl because the jitney article is less valuable than one I could buy if I had a dollar.



In the present article Mr. Armstrong Perry tells how one may acquire at small cost, a simple and efficient radio receiving station, suitable for picking up radiophone concerts or radio-telegraph messages. As the diagram herewith shows, such a simple receiving set comprises a two-slide tuning coil, a fixed condenser, crystal detector, a pair of high resistance phones, together with suitable protective device, such as a vacuum gap.

The fact is that for some parts the five-and-ten-cent store people get about as much as other dealers. Stripping down a device so that the purchaser pays five cents apiece for twenty component parts instead of a dollar for the assembled article is not cutting prices. It is merely taking advantage of the psychological fact that many people will loosen their hold on twenty nickels, one at a time, easier than they will drop a dollar all at one time.

Anyhow, the five-and-ten-cent store always makes me feel as though I could own any type of receiver I want. Assuming that you are within ten or fifteen miles of a good broadcasting station and will be satisfied with a crystal detector set, although you will have to wear the phones in order to hear anything, I propose a ten dollar outfit. At the low-price store the parts can be purchased at the rate of a dollar's worth a week if it is necessary to get them out of a very slender income.

The first thing to buy is a plan. A beginner cannot hope to succeed if he starts without a plan or if he changes his plan to conform to the numerous suggestions of his friends. Get the plan and stick to it. The blue print costs about ten cents.

A panel and base are desirable though not indispensable. These are what the apparatus is fastened to. Ready-made ones can be purchased in some places as low as a quarter. Respectable ones can be cut from a packing box. The plan gives the dimensions, which may be five by nine inches, more or less, for the panel and a little larger for the base. It is well to have the base a little thicker and to put a cleat at each end on the bottom to prevent warping and then raise the middle of it from the table a little.

The plan shows a number of holes to be bored for binding posts, switch points and control knobs. The better this boring is done the better the set will work and the neater it will be in appearance. The wood may be finished with a one-cent sheet of sandpaper and a ten-cent can of stain, paint or varnish.

For the beginner who wants to learn about the action of radio waves while he builds his set, it is well to begin assembling at the point where the current enters the receiver and to prepare the way for its passage through the receiver step by step, keeping in mind what is going to happen at each point when the apparatus is operating. He may even want to begin with the aerial, which is often left till the last. In this case he will want a dollar's worth of antenna wire, usually a seven-strand No. 14 copper wire; two or more porcelain insulators costing five or ten cents each; as much rope as is necessary to fasten his insulators to the poles, buildings or trees that are to serve as points of support; screw eyes to fasten the rope to; and a pulley to permit the antenna to be lowered or tightened. In place of this paraphernalia the beginner may prefer to buy one of the numerous plugs now on the market for attaching the receiver to the electric light socket and to use the light wires for an antenna. I have tried a number of these plugs and they work all right in many places. When they do work they save all the trouble of putting up an antenna and protective devices and the expense is reduced.

A screw eye high up on a pole or wall, a short length of rope with a pulley on the end, a rope rove through the pulley long enough to reach to the ground and back again, an insulator on one end of this, the antenna wire run through the hole in the other end of the insulator and then wrapped neatly around itself—that completes the far end of the antenna. At the near end the wire is fastened to the second insulator, the insulator to another short rope and the rope to another screw eye. If instead of fastening the rope to a stationary object at the bottom you attach to it a hanging weight, the antenna will be held taut in spite of the stretching and shrinking of the rope and will be steadier in the wind.

From the insulator the wire drops to the lightning switch. Underwriters require a 100-ampere switch and they feel better if there is a lightning arrester also. The man who has ten dollars to spend for a receiver will find it all gone after acquiring these items. A common practice is to compromise on a 30-amp. switch that costs about a cent per ampere. Between the underwriters and the insured I am neutral. Fires traceable to antennae are of rare occurrence. On the other hand they may occur and violation of underwriters' regulations is legal cause for refusal to pay losses.

From the switch a wire goes into the ground, or to a metal pipe that goes into the earth. The lightning, if polite, will follow this wire rather than the one leading into the house. The one that enters the house passes through the wall in a porcelain tube and goes by the shortest practicable route to the receiver. The tube costs a dime.

The current set up in the antenna by the radio waves enters the receiver at a binding post that is usually located at the upper left hand corner of the panel. This binding post and another for the ground connection can be made of ordinary brass machine screws. They need to be about an inch and a half long and each one needs two washers, one for each side of the panel, and three nuts. With a nut outside the washer on each side of the panel fastening the bolt in place, the third nut is used for attaching the antenna wire, or lead-in wire as that part is called, which reaches from the lightning switch to the receiver.

The next thing in the pathway of the current is usually a tuning coil. I frequently omit this and listen in with nothing but a detector and a pair of phones. Radio men expatiate on the awful interference encountered when there is no tuner to use in selecting the stations you want to hear. From years of experience in such crowded radio areas as New York City and Washington, I can testify that it is possible to get along without a tuner and still enjoy concerts without undue interference if you are near enough to one good broadcasting station. I suspect that the radio experts, working always with the latest and most sensitive apparatus, have forgotten how much less interference the crystal detector brings in than the tube set. It is the exception rather than the rule when I am interfered with while listening to a concert or copying Government code broadcasts, though I know that scores of other stations may be working within my range and that I could bring in any one of them by finer tuning. Of course I hear principally the nearest and most powerful stations, but when working with crude apparatus I am entirely satisfied with that.

The type of tuner used, if one is used, will vary according to the plan purchased. There are single and double-slide tuning coils; coils with wires leading off every ten turns more or less, and ten single turns tapped for fine tuning; variocouplers and variometers. The variometer, a very efficient tuner, used to be hard to make but

(*Continued on page* 923)

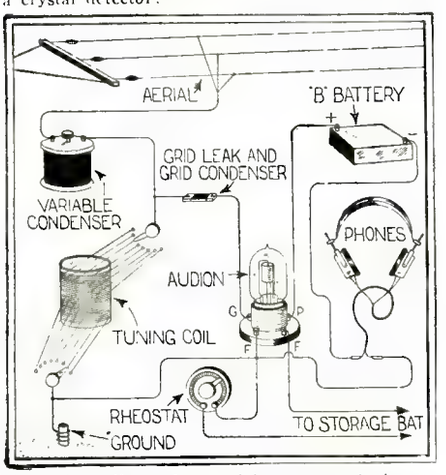
Radio Oracle

In this Department we publish questions and answers which we feel are of interest to the novice and amateur. Letters addressed to this Department cannot be answered free. A charge of 25c is made for all questions where a personal answer is desired.

RECEIVING RANGE OF CRYSTAL SET

(91) Leslie Averill, Little Sauk, Minn., says that he has read the advertisement of a company which states that they are selling a crystal receiving set, which will respond to radio concerts over a distance of 200 miles. He asks:

Q. 1. Is it possible to do such work with a crystal detector?



A single audion tube receiving set employing a tapped tuning coil, is shown herewith. This hook-up is very easy to adjust and fairly selective.

A. 1. We would say that the company putting out the receiving set you mention is stretching things a little when they say it will receive radio concerts consistently over a distance of 200 miles. A crystal detector cannot be depended upon to receive radiophone over more than 30 miles, except under ideal conditions. However, we do not doubt that spark signals could be heard over this distance, that is, 200 miles.

Q. 2. Kindly give a hook-up for a variable condenser, a coil wound on a single tube, and tapped in two sections, and an audion detector.

A. 2. We give herewith the circuit diagram, as requested.

INCREASED EFFICIENCY

(92) Louis W. Baker, Raleigh, N. Caro., asks:

Q. 1. Would I increase the efficiency of my set which is now mounted on two panels by mounting all the instruments on one panel?

A. 1. We do not believe that you will get one bit better results by mounting your set all on one panel, instead of on two, unless you are using very long leads between the two panels in their present form. If the latter is true, you may secure better results by bringing your sets together as above mentioned.

Q. 2. Since I am only using two "B" batteries on my amplifiers, do you think that the addition of more "B" batteries would increase the efficiency of the set?

A. 2. No doubt the addition of more "B" batteries to your amplifying tubes would be advantageous. We would advise you to experiment and find out just what voltage your tubes work best on.

TROUBLESOME HUM

(93) Elton E. Bigelow, Worcester, Mass., says: I am bothered with a bad hum in my receiving set which can be heard even with the tube out of the socket, and I have tried various hook-ups but have been unable to eliminate it. He asks:

Q. 1. Can you tell me the cause and its remedy?

A. 1. It would seem from the description of the "hum" which you give, that it comes from the proximity of AC lines to either your antenna or your set. We would advise you to see whether or not your aerial runs parallel to or nearly parallel to any AC line. If this is so, you will probably find that the "hum" will be eliminated, or at least reduced to a minimum, by placing your antenna at right angles to the line.

It may also be that the "hum" is caused by the lead-in running near AC wiring in your house. If this is so, shield the lead-in by covering it with lead foil, or thin sheets of lead. Also shield any connections in your set in the same way, which come anywhere near the lighting wires.

If your instruments are in a cabinet, we would advise shielding the panel by means of tin foil or aluminum sheets, fastened to the back of the panel and grounded. In doing this, be sure that no metallic parts of the instruments touch the foil or metal sheets.

CONNECTING AMPLIFIERS TO DETECTOR

(94) Joe Brimmer, Alberta, Canada, asks:

Q. 1. Will you please tell me how to connect the amplifying circuit shown on page 254 of the July issue of SCIENCE AND INVENTION to the detector?

A. 1. All that it is necessary for you to do to connect the amplifying circuit you mention, to a detector circuit, is to connect the leads marked "to detector" to the same place in the plate circuit of the detector tube to which the phones are connected when only that tube is being used.

VARIO-COUPLER QUERY

(95) Wm. Arenson, Cuyahoga Falls, Ohio, asks:

Q. 1. Should the primary of a vario-coupler be tapped?

A. 1. Yes, for best results. It should be preferably tapped in units and tens, although tens alone will work. The unit taps, however, will give finer tuning.

Q. 2. Please give data on the construction of a vario-coupler.

A. 2. A good coupler would consist of a tube four inches in diameter on which is wound 66 turns of No. 20 SCC wire. This is tapped every six turns for the first 60 turns, and then every turn for the next six turns. The secondary of this coupler should be wound with about 35 to 40 turns of No. 22 SCC wire.

Of course, these figures are only approximate, and although they will probably give very good results, we would advise you to experiment a litle. The amount of wire will depend somewhat upon the size of your aerial, and other factors, which may best be determined by experiment.

CHARGE FOR LISTENING IN

(96) Austin Bushy, Morrill, Nebr., asks:

Q. 1. Do you think radiophone broadcasting stations would have any objection to my giving radio concerts with my receiving set and charging admission thereto?

A. 1. We see no reason why there should be any objection to this. As a matter of fact in New York City an amateur realized quite a bit of money by charging admission for listening in to the returns of the Carpentier-Dempsey fight.

Q. 2. What would be the cost of a station sensitive enough for this work?

A. 2. The cost of a station capable of receiving over several hundred miles, and throwing the received signals 40 feet from the loud-talker, would be in the vicinity of $350 00. You will find a complete list of concerns supplying these instruments in the advertising columns of this journal. We would advise a type of set similar to that described on page 156 of the June issue of SCIENCE AND INVENTION, used in connection with an outdoor antenna about 100 feet long, and some type of efficient power amplifier.

In January Practical Electrics

Electric Arc Soldering.

Edisonia.

Titanic Power Circuit.

Electric Steam Generator.

English Electric Heaters.

Electric Hardening and Tempering Process. By Maurice E. Pelgrims, Belgian Correspondent, Practical Electrics.

Oscillating Electric Fan.

Coal Scale Indicator.

Small Hydroelectric Plant. By A. L. Cavanaugh.

Measuring Distances by Automobile.

IS AN AERIAL NECESSARY?

(97) C. S. Payne, Topeka, Kan., asks:

Q. 1. Is it absolutely necessary to use an antenna for efficient reception of radiophone?

A. 1. Some form of aerial is generally necessary, the type being dependent partially upon the kind and amount of amplification used. The aerial, for instance, could be in the form of a small loop, a bed spring, umbrella, or fire escape, providing sufficient radio and audio frequency amplification were used in connection with the same. Many amateurs have been successful in receiving radiophone concerts without the use of any aerial whatsoever, the waves being picked up by the inductance of the tuning devices themselves. However, to all practical intents and purposes, this method is very unreliable.

REWINDING PHONES

(98) C. W. Morris, Buchanan, Mich., inquires:

Q. 1. Can I re-wind a pair of Western Electric two pole receivers to 3,000 ohms resistance with the wire from the secondary of a Ford spark coil?

A. 1. We doubt very much whether you can get enough wire from the secondary of a Ford spark coil upon the Western Electric receiver pole pieces, in order to give them a resistance of 3,000 ohms. We would suggest that you determine the size of wire used on the secondary of a spark coil which you have and from any series of wire tables get the resistance in ohms per foot for this particular size. Divide this resistance into 1,500, and that will tell you how many feet of wire are necessary for each receiver. Halve this amount, and place one half on each pole of one receiver. Wind the same amount of wire on the pole pieces of the other receiver, and you will have two receivers with a resistance of 1,500 ohms each. By connecting the two receivers in series, the total resistance will be 3,000 ohms. Some Ford coils have a secondary with relatively heavy wire, hence our doubt.

CONDENSER DATA

(99) I. A. Nerver, Lockport, N. Y., inquires:

Q. 1. How many, and what size, glass plates must be used to build a condenser for use with a 1 K. W. radio transformer?

A. 1. We would advise a glass plate condenser made up of 40 glass plates 16 x 19 inches, placed alternately with thin metallic or metal foil sheets 10 x 13 inches. These plates are made up in two units, which are connected in series-parallel. The capacity of this condenser is .019 M. F.'s on 60 cycle currents.

GRID LEAKS

(100) Lloyd Toth, New York City, asks:

Q. 1. What is a grid leak, and what is its use in a radio circuit?

A. 1. A grid leak is usually a high resistance, a graphite rod or a piece of paper coated with graphite which is placed in the grid circuit of an audion detector tube. Its purpose is to serve as a by-pass for the radio frequency currents, which otherwise would collect on the grid of the tube, thereby rendering it unstable.

Q. 2. Must the grid leak be variable?

A. 2. For very best results, the grid leak should be variable, although after it has been set for a certain tube it may be left in that position until another tube is used, whereupon it should be readjusted to suit the characteristics of the new tube.

Q. 3. In some radio diagrams I see the grid leak shunted across the grid condenser, while in others it is connected from the grid to the filament. Which is correct?

A. 3. The most generally accepted method is to shunt the grid leak across the grid condenser, but in some cases with certain circuits and tubes, it is found advantageous to connect the grid leak from the grid to the filament, rather than across the condenser. In connecting up a set you should try both positions and ascertain which one works best.

TWO-SLIDE TUNER CIRCUIT

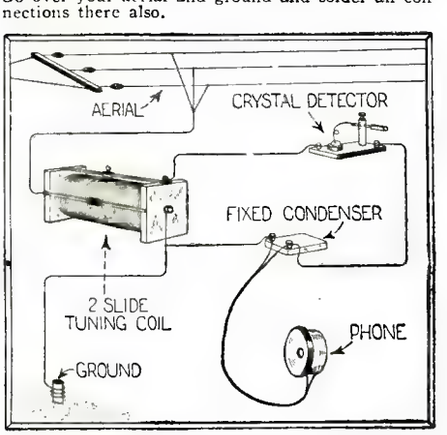
(101) Robert Brandon, Grand Rapids, Mich., requests:

Q. 1. A circuit diagram of a two-slide tuner, a crystal detector, a fixed condenser and a single phone.

A. 1. We give herewith the circuit diagram requested.

Q. 2. I have hooked-up this set myself and am unable to hear anything with it. Can you tell me what might be wrong?

A. 2. It is practically impossible for us to say just what is wrong with your set. It may be that the circuit diagram you are using is not correct. We would advise you to check this and also see that all your connections are tight, and soldered, if possible. Go over your aerial and ground and solder all connections there also.



A two slide tuner may be connected with a crystal detector, as shown herewith. Either a single phone or a pair of receivers may be used.

LATEST PATENTS

Combined Blood Pressure and Respiration Instrument

(No. 1,433,679 issued to Eugene L. Fisk)

A notable addition to the doctor's instrument case will be this sphygmomanometer and spirometer,

whereby the same gauge is employed for measuring blood pressure and respiration. Thus, immediately following the blood pressure test, by merely shutting off one valve and opening another, a respiration test may be instituted without detaching the sphygmomanometer circuit and cuff, by bringing the mouthpiece of the spirometer into use. A U-shaped transparent tube containing a predetermined quantity of mercury, oil, or other liquid substance, is designed to be forced under pressure from the bulb into the sealed arm to produce a readable column for gauging the pressure required to lift the same.

Swimming and Exercising Device

(No. 1,433,142 issued to Louis Albert Maurer)

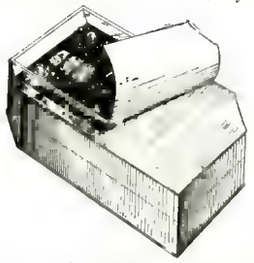
Here is another swimming device which can be used indoors and out-of-doors for exercising and teaching swimming. A body plate provided with a chin rest, is so supported that moving it to either side, causes the rudder to swing. In this way the device can be steered. Two long levers having mittens at their extremities, receive the hands. These

levers, through suitable gearing, cause the movements of both arms to be coordinated, and actuate the foot mechanism, which spreads the legs of the swimmer, draws them toward his body, forces them outward again, and raises them in direct relation to the movements of the hands.

Illusionary Box

(No. 1,430,642 issued to David Ellis Hamburger)

This invention is for application to boxes or containers for small articles that are customarily laid

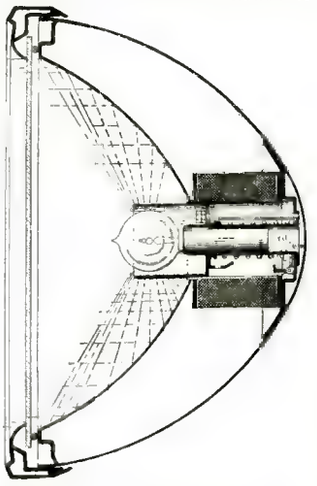


open to view when on sale, such as candy, cigars, etc. The corner of each box of candy or cigars is made so as to appear as though cut off at an angle and on top of the box a sheet of paper, printed to make it resemble a transparent top through which the contents of the box are viewed, is pasted. In this way the purchaser obtains a true picture of the contents of the box, so that he thinks he is seeing the real articles.

Lamp Dimmer

(No. 1,426,162 issued to Charles W. Eisele)

Instead of dimming the headlight of an automobile by one of the usual methods, such as cutting resistance into the circuit, the inventor of this system arranged his lamp bulb upon an iron plunger. When current is permitted to pass into a solenoid, the plunger or core to which the bulb is attached, is drawn inward into a shield, so that only the parallel rays of light are permitted to pass through the lens of the headlights. A locking arrangement holds the lamp in its retracted position, whereupon by merely closing a switch the lamp is again projected from its dimming shield. In a second embodiment of the same patent, instead of securing the bulb to the core of a solenoid, it is held in fixed relation to

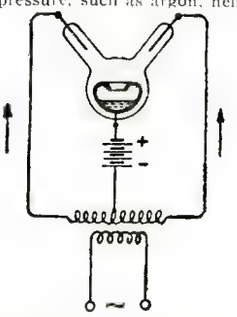


the reflector and a shield is projected around the lamp for dimming the rays or drawn back again when bright lights are desired.

Vacuum Rectifier

(No. 1,434,310 issued to Johannes Nienhold)

A vessel filled with a rare gas at low pressure, such as argon, helium,

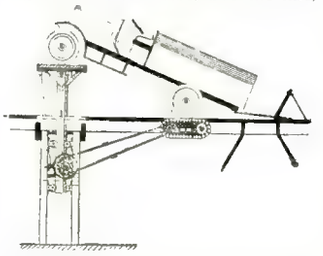


or the like, has an electrode in it of highly positive material, and one or more of highly negative material, the materials used being potassium or an alloy thereof as the cathode and constantan or copper as the anode. The voltage between the electrodes is adjusted to produce a discharge of the glow type. Arc discharge rectifiers have but slight rectifying effect, whereas, in this device, surprisingly large currents may be rectified, even as much as one hundred amperes are delivered by one single tube. The cathode of the tube is in the shape of a basin containing the potassium or other alkali metal.

Dumping Mechanism for Automobile Trucks

(No. 1,433,743 issued to James D. Renne)

Where large numbers of automobile trucks are not provided with devices for facilitating their dumping in mills, elevators, and the like,



this invention will prove effective for unloading grain. By glancing at the diagram the reader will note that a caterpillar tread is mounted slightly below the surface of the pavement so that the upper surface of the caterpillar tread will be flush with the pavement. The rear end of the motor truck is anchored, its forward wheels resting upon a platform. By causing the engine to drive the rear wheels, the front of the truck is elevated, due to the action of the caterpillar tread, rotating an endless chain geared to the rising platform.

Air Craft Signaling

(No. 1,426,413 issued to John Clifford Savage)

Signs in the air are made possible by this invention, which is so designed that an aircraft in flight will leave a visible trail of smoke at intervals of the flight, and by maneuvering the craft so as to form signs, characters or words in the air, observers on the ground are made able to distinguish the advertisement. Two or more separate receptacles in which chemicals are stored, are brought into reaction or admixture with one another when released, either apart from or in conjunction with the engine exhaust gases. For example, one material may be finely divided carbon and

the other material may be oil, the latter may be vaporized in the engine exhaust passage before the carbon is mixed with it, the essential feature being that when both materials are released and brought in contact with each other, they produce a visible medium.

Heater for Bottles

(No. 1,434,472 issued to Charles Anselm)

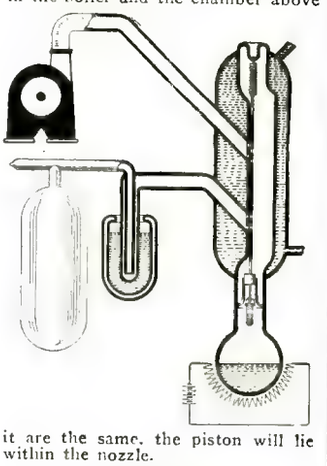
Here is an electric heater which is adapted for attachment to receptacles, such as bottles, hot water bags, and the like, which may readily be screwed into an electric light

socket. The tapered construction of the top of this device enables it to form a closure for receptacles having necks of varying sizes. A plug is fastened to one end of this taper and from the other end a tubular member containing a coil of resistance wire depends. This member is removable and is surrounded by a metallic casing, which completely encloses the resistance wire and forms a liquid-proof cover.

Vacuum Pump

(No. 1,434,851 issued to Homer Clyde Snook and Oliver E. Buckley)

This is an auxiliary pump, employing as a pumping medium a suitable vapor, which vapor issues in puffs, driving the gas to be exhausted toward the roughing pump. The device is particularly adapted to producing very high vacua. As illustrated in our sketch, a boiler is surrounded by a heating coil, to vaporize mercury, tin, lead, bismuth, or some other suitable material. This vapor is employed as the pumping medium and should be condensable in the walls of the chamber above. A valve having several openings therein, is mounted within the condenser above the boiler. A spring is secured to either end of this valve and a piston adaptable to close a nozzle is located in the top of the boiler. The springs are so adjusted that when the pressure in the boiler and the chamber above

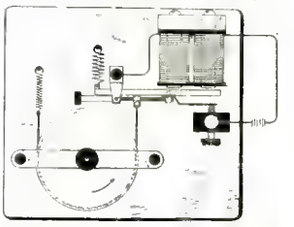


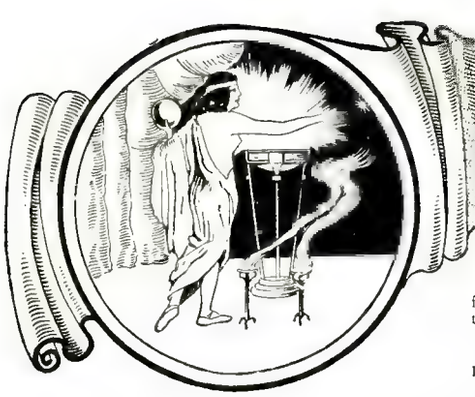
it are the same, the piston will lie within the nozzle.

Electric Motor

(No. 1,433,562 issued to Fritz P. Mansbendel)

The design of a very simple slow-running motor for advertising signs, which will operate on either battery current, or on alternating or direct current, is given in this patent. The motor runs very slowly and no gears are employed. As will be seen by the diagram, what practically constitutes an electric bell, has a rod added to its armature, threaded, so that the position of a belt may be shifted. A large grooved pulley or disc, is mounted between two bearings, the belt passing around one half its circumference, being secured at the further extremity by a spring. The speed of rotation of the device is varied by adjusting the position of the belt on the armature, and the number of vibrations of this armature. Friction between the cord and grooved pulley gives rotary power.





THE ORACLE

The "Oracle" is for the sole benefit of all scientific experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be published. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addressed to the department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

SNEEZE POWDER AND LAUGHING GAS

(1371) Robert Galiano, New Orleans, La., requests.

Q. 1. A formula for the preparation of a good strong sneeze powder.

A. 1. We give herewith a formula as requested.

Sage	1 oz. av.
Wild Giner	1 oz. av.
White Hellebore	60 grains
Powdered Orris Root	1 oz. av.
Powdered Soap Bark	1 oz. av.
Bayberry Bark	1 oz. av.

Q. 2. Please give also directions for the preparation of laughing gas.

A. 2. Laughing gas or nitrous oxide may be prepared by heating ammonium nitrate in a retort. The gas given off is nitrous oxide in a form to use as laughing gas.

RECTIGON QUERY

(1372) Dr. Jorge R. San Pedro, of Cuba, asks:

Q. 1. How shall I change a Rectigon rectifier, designed to operate on 110 volts, so that it may be used on 80 volts A. C., 50 cycles?

A. 1. We doubt that any changes must be made on your Rectigon circuit, in order to use the same on 80 volts, and 50 cycles. The secondary voltage or charging voltage is lowered however.

STETHOSCOPE CONSTRUCTION

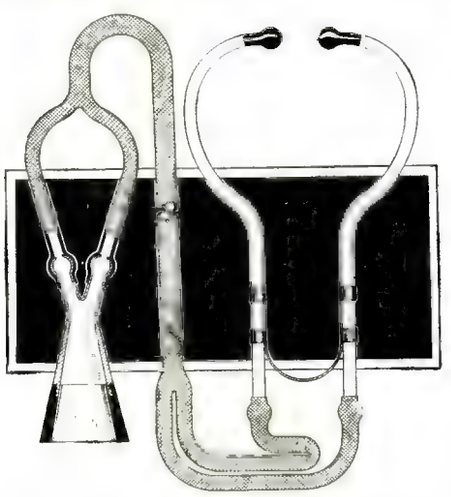
(1373) Geo. Walthers, Toledo, Ohio, requests:

Q. 1. Will you please give me data for building a stethoscope such as that used by physicians?

A. 1. A stethoscope such as is used by the physicians varies greatly in size. For instance, there is an infant stethoscope, the orifice of which is about as large as a five-cent piece. This opening tapers toward the distal end where it communicates with two openings.

To these openings rubber tubes are attached terminating at the usual ear attachments. Other stethoscopes are much larger, some with the flaring end, the size of a quarter dollar, and the diaphramatous stethoscope with end the size of a half dollar or larger. It really does not make much difference as to what size stethoscope you build; they all work.

The main thing about the stethoscope is to have it so arranged that it will cover a certain area when placed in contact with the skin. The skin will act as a diaphragm, and the column of air between the person's body and the ear of the physician is perfectly enclosed. We give herewith an illustration showing a cross-section of a stethoscope.



This drawing shows the construction of the ordinary physician's stethoscope. It is a purely acoustic affair, and has no electrical arrangements. There is, however, a new type of supersensitive electrical stethoscope on the market, which makes it possible by means of a microphone, receiver, and battery, to hear extremely weak heart sounds.

LENGTH OF HEAT WAVES

(1374) Chas. Leichner, Paonia, Colo., wants to know:

Q. 1. What is the wave-length of heat waves?

A. 1. The wave-length of heat waves varies from 0.810 to 314 microns; a micron being one-millionth of a meter.

Q. 2. If they are very short, how is it that we can sometimes see them on hot days?

A. 2. When looking into the distance on a hot day and seeing the heat waves rising, you do not really see the heat waves, but you see air currents which have been heated, and are therefore rising.

BLACKENING BRASS

(1375) G. A. Mitchell, Los Angeles, Calif., asks:

Q. 1. How can I produce a black surface on brass quickly and without the use of heat?

A. 1. Without a doubt the only way to blacken brass so that it will act quickly, require very little attention, and will not come off very easily, is to dip it in black lacquer. If you desire a chemical change, you must either give it plenty of time or apply heat.

FIRE AND ACID PROOF PAINT

(1376) Donald A. Moore, Alstead, N. H., requests:

Q. 1. Kindly tell me of a paint which will make the tables and walls in my chemical laboratory fireproof and acid-proof.

A. 1. It will be rather difficult to get a paint which will be both fire and acid-proof, but if you will coat your laboratory tables and walls with several coats of water glass, which may be procured upon the open market under the trade name of sodium silicate or "Keepex", you will find that you have obtained a very efficient and satisfactory surface. Zinc oxide and ammonium chloride should be added to subsequent coatings after the second which is mixed with the sodium silicate.

In "Practical Electrics" for January

Electric Arc Soldering.
Edisonia.
Titanic Power Circuit.
Electric Steam Generator.
English Electric Heaters.
Electric Hardening and Tempering Process. By Maurice E. Pelgrims, Belgian Correspondent, Practical Electrics.
Oscillating Electric Fan.
Coal Scale Indicator.
Small Hydroelectric Plant, By A. L. Cavanaugh
Measuring Distance by Automobile.

VACUUM

(1377) J. A. Murphy, Ontario, Canada, wants to know:

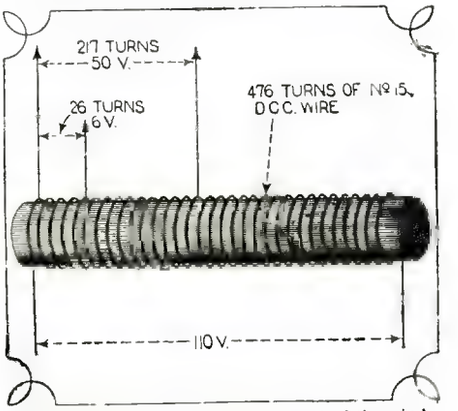
Q. 1. What constitutes a vacuum and are there different degrees of vacuum?

A. 1. A vacuum means the absence of air or gas from an unfilled space. A perfect vacuum cannot be obtained, however, and as near perfect as we have been able to obtain is .0003 millimeters of mercury. There are, of course, different kinds of vacuums. Thus an incandescent bulb is not evacuated very highly; a Geissler tube still less, whereas there is a very good vacuum in an audion detector. You see, therefore, that while there are various degrees of vacuums, we have not as yet been able to produce a perfect vacuum. Theoretically, the universe is supposed to exist in a perfect vacuum and atmosphere surrounds only the earth and other heavenly bodies. In view of the fact, however, that a gas expands indefinitely, it would seem that even the universe as we know it would have an atmosphere. Therefore, although the amount of atmosphere there would be very small it would still be in existence, if the rule just mentioned is true for interstellar spaces.

AUTO-TRANSFORMER DATA

(1378) M. E. Oliphant, Crestline, Ohio, requests:

Q. 1. Will you please give me the necessary data for constructing a step-down auto-transformer to reduce 100 volts, 25 cycle A.C. to 6 and 50 volts?



This diagram shows the arrangement of the windings on an auto-transformer, whereby the voltage on an A. C. circuit may be either reduced or increased.

A. 1. Wind an iron core 15 inches long by 1 inch in diameter, with 476 turns of No. 15 double cotton covered wire in layers. This iron core is composed of a bundle of iron wires. At the end of 26 turns a tap is taken off, and at the end of 238 turns, another tap is taken off, as indicated in the accompanying illustration. These taps will give the required voltages of 6 and 50 respectively.

STEP-DOWN TRANSFORMER

(1379) S. C. O'Dell, Cincinnati, Ohio, asks:

Q. 1. How can I construct a 100-watt step-down transformer to reduce 110 volts, 60 cycle, to 18 volts, 7 amperes?

A. 1. What you desire to do is impossible, inasmuch as 18 volts at 7 amperes is 126 watts. The efficiency of a closed cored transformer is only about 94%, and therefore only about 94 watts can be drawn from a 100-watt input transformer.

WHAT IS A HORSE-POWER?

(1380) Orma L. Gibbs, Kansas City, Mo., says:

I have made several discoveries about mechanics which I do not find in any book on physics. One is that there is practically no limit of speed at which one horse-power can be generated. The general idea of power is that if you increase the speed you lose power, and if you increase the power you lose speed. You will have to admit that a horse-power is a horse-power, regardless of how long it takes to generate it. If a one horse-power motor generates one horse-power in one minute, and a ten horse-power motor generates ten horse-power in one minute, then any one of these ten horse-power is generated ten times as quickly as one horse-power by itself. He asks:

Q. 1. Is my reasoning correct, and if not, can you put me right?

A. 1. A horsepower is the amount of energy required to raise a weight of 33,000 pounds to a height of one foot in one minute. All these factors must be taken into consideration. Thus a one horse-power motor if operating at full efficiency and disregarding friction, will raise a weight of 33,000 pounds one foot in one minute, and a ten horse-power motor will lift the same weight ten times the height in one minute, or lift ten times that weight one foot in one minute, or lift the same weight to the same height in one-tenth of a minute.

But remember that in doing this you are using the full horse-power which the motor is capable of delivering, and if you should stop the motor after one tenth of a minute, you have still used up the equivalent in power to the amount used by the one-horse-power motor operating for one minute. Factors such as starting, resistance, friction, etc., have been disregarded in this discussion. The "power" of your question is an inheritance from the past, and in modern nomenclature should be "force."

RELATIVE SPEED OF DIFFERENT PARTS OF A WHEEL

(1380) L. A. Morrison, Shoshoni, Wyo., asks:

Q. 1. Does the top of a wheel travel faster than the bottom? Please explain.

A. 1. We do not see any reason why the top of a wheel should travel more rapidly than the bottom of the wheel. If you were to place a speedometer upon the wheel, you would find that their movement is exactly the same. Any attempt to make the top of the wheel move faster than the bottom of the wheel will distort its shape to such an extent, that it could no longer be called a wheel. The above refers to a wheel free to rotate in air.

Now, referring to a wheel on the ground, we would say that when the wheel is stationary, the point touching the ground has no velocity. If the wheel is now started in motion (rotating) this velocity increases until the point formerly on the ground reaches the top of the wheel. This point continues down again as the wheel moves forward, and gradually decreases its velocity, until it again touches the ground, where its velocity is nil. The mean velocity is equal to the speed of the axle, and the above paradox refers to the velocity of any point on the circumference of the wheel.

COLOR CHANGING BY ELECTRICITY

(1381) C. M. Huttig, St. Louis, Mo., wants to know:

Q. 1. Is there any substance, either liquid or solid, which when acted upon by an electric current will turn black? Also is there any substance which will turn white when acted upon by electricity?

A. 1. We cannot give you any definite answer to your question without a considerable amount of research work, which we believe you will be able to do very well yourself. We are, therefore, giving you a few suggestions for the same.

Try suspending two iron electrodes in a solution of tannin, and connect the electrodes to a source of current. It is possible that the current may liberate a certain amount of free iron, which will be attacked by the tannin, thereby forming ordinary black ink. Again try two wires stuck in a slice of raw potato. A change of color will be effected upon connecting the two wires to a source of current. A solution of phenolpthaleine will change color when a current is passed through it, that is, it will change from clear to pink, but will return to its normal color when the current is removed and the solution is shaken.

TWO-SIDED PHOTOGRAPHIC PAPER

(1382) J. C. Molotor, Swedesboro, N. H., wants to know:

Q. 1. Can photographic paper be sensitized on both sides and two pictures be printed thereon from the same negative?

A. 1. Photographic paper can be coated on both sides with any one of the ordinary sensitizing solutions, several of which have been printed in this magazine. The paper, however, must be very thick and impervious to light rays. Both sides will have to be exposed before the paper is developed. However, we see no particular advantage in paper of this nature, as it is much more satisfactory and cheaper to paste two prints together back to back after they are finished, for the reason that the heavy cardboard which must necessarily be used in the former method, is quite expensive and very wasteful. When prints are made on separate sheets it is always possible to see how one turns out, before printing another. However, if both prints are made at one time, they may both be failures. Another disadvantage of the heavy card is that unless a very special quality is used, the card is liable to soften and come apart when it is placed in the developing, fixing and washing baths.

MOLDABLE WAX

(1383) F. N. Laubenthal, Toledo, Ohio, inquires:

Q. 1. What substance of any nature with a body can be rolled into plates, which plates, when placed in contact with sufficient dry heat or immersed in hot water of say 150 degrees F, or in other words, just hot enough to be handled with the bare hands, will become pliable and take the shape of any substance placed thereon, such as hand prints, etc., and which will when cool, retain the impressed shape?

A. 1. There are many substances which will do the work you desire. For instance, the wax such as dentists use. This is a moldable wax which is heated slightly before it is used, and takes on a very perfect impression. It also has the advantage that it can be used over and over again. There are many other compositions which you might experiment with for your work, such as engravers' border wax, impression wax, gelatine, etc. Not knowing to what purpose you desire to put such a compound, we cannot give you further information.

CLEARING BLOODROOT TONIC

(1384) George Gilliland, Bronx, N. Y., says:

I have been trying for some time to make a tonic out of bloodroot, and I find that no matter how much I filter it, there still remains a certain amount of sediment. He asks:

Q. 1. Could you suggest some way by which I could clarify this liquid?

A. 1. The possibility of obtaining a clear bloodroot tonic is not very great, in that an extract of bloodroot contains a considerable amount of gums, and therefore, when this alcoholic solution is mixed with water, the gums precipitate. We would suggest, however, that you try filtering the solution after all its ingredients have been added through a filter, upon which a quantity of magnesium carbonate has been placed, test the filtrate for a carbonate, and determine the quantity, as it will probably do no harm in such small doses. We believe this will give you a clear solution.

FUSE WIRE

(1385) Thomas O'Malley, New York City, wants to know:

Q. 1. Whether the fuse wire in an ordinary fuse depends for its action upon its thickness or its length?

A. 1. The fuse wire in the ordinary fuse generally depends upon its thickness rather than its length for its proper fusing, assuming that the composition of the wire is the same. Of course a short thin wire will fuse quicker than a long wire of the same diameter, providing that but a very slight overload is placed upon the short wire, in that the length of the wire cuts down the current considerably. In sudden heavy overloads the length could be disregarded, as either long or short wires of the same diameter would melt almost instantly.

METHODS OF IRRIGATION

(1386) Ole Nors, S. Vallejo, Cal., says:

There are large tracts of land in this part of the country which only need irrigation to turn them into wonderful pasture land. We have tried different forms of irrigation and have found several of them to be failures. For instance the surface irrigation will not work because of the rapid evaporation of water from the trenches. Water is very scarce here, and therefore, this method is not good. We have also tried laying porous clay pipes underground, and allowing the water to flow through them. From these pipes the water seeps out slowly, thereby moistening the ground around it. This method is all right for the first year of its installation, but the roots of the grass soon clog the porous pipes, and render the system inoperable. He asks:

Q. 1. Can you suggest any other method which might work under these conditions?

A. 1. Run a system of pipes underground, and, at short intervals, a pipe leading downward to the ground, terminating 6 to 12 inches below the surface. It is possible that this method may work in your case. The area around the smaller pipes should be of sand or gravel for a distance of two or more feet. In Florida subsoil irrigation with perforated or porous distribution pipes is used.

IMPORTANT

TO NEWSSTAND READERS

IN order to eliminate all waste and unsold copies it has become necessary to supply newsstand dealers only with the actual number of copies for which they have orders. This makes it advisable to place an order with your newsdealer, asking him to reserve a copy for you every month. Otherwise he will not be able to supply your copy. For your convenience, we are appending herewith a blank which we ask you to be good enough to fill in and hand to your newsdealer. He will then be in a position to supply copies to you regularly every month. If you are interested in receiving your copy every month, do not fail to sign this blank. It costs you nothing to do so.

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Paper Matches

(1387) Ernest J. Delo Curesto, New York City, N. Y., sends a sample of an ordinary paper match, and asks:

Q. 1. Can you tell me the composition of the paper of these matches?

A. 1. Paper matches are made by merely impregnating several layers of paper with paraffin by submerging them in a vat of molten wax, after which they are placed under pressure. The sheets are now stamped by machinery into the well known form. After this is done, the tips are dipped into the igniting solution.

Producing Acetylene

(1388) George E. Custer, Stoyestown, Pa., asks:

Q. 1. Can you suggest a good chemical combination that will produce a gas that will burn with a clear white light?

A. 1. Probably the best way to obtain the gas for a small light, would be to use calcium carbide, upon which water is allowed to drip. Acetylene gas is produced, which burns with a very clear white light. There are hundreds of different types of so-called carbide lights on the market which use this principle, and are advertised as bicycle lights, motorcycle lights, etc.

Rectifier Queries

(1389) James R. Crow, Birmingham, Ala., says that he has several times seen descriptions of electrolytic rectifiers in this magazine with several electric light bulbs, wired in series with the A. C. side of the same. He asks:

Q. 1. How many lights and what size should be used?

A. 1. The number of electric light bulbs which are wired in parallel and connected in series with an electrolytic rectifier, depends upon the amount of current you wish to draw from the rectifier. For instance, if you wish to draw approximately one ampere from your rectifier, use one 100-watt tungsten light in series with it. If you wish to draw two amperes use a 200-watt light in series, or two 100-watt lights connected in parallel, and the two connected in series with the rectifier. In other words, allow 100 watts for every ampere you wish to draw from the rectifier. Due to the fact that a 100-watt lamp does not draw one ampere exactly and because there are slight losses in the rectifier, the full one ampere cannot be obtained with the single 100-watt lamp.

Q. 2. In the description of rectifiers, the sizes of the jars and plates are very seldom given. Can you supply these dimensions?

A. 2. To make a rectifier, use four one-quart fruit jars, or even larger jars may be used, and place in each one a lead and an aluminum plate as large as will conveniently fit therein and still remain one to two inches apart. The exact sizes of the plates is practically immaterial (4½ inches by 6 or 7 inches is very successful in battery charging devices).

Denatured and Medicated Alcohol

(1390) Forrest W. Crannell, Langford, S. D., requests:

Q. 1. How are denatured and medicated alcohol made, and what is the difference between the two.

A. 1. Denatured alcohol is made by adding about 10% of wood alcohol to grain alcohol, thereby making it unfit to drink. In addition to the wood alcohol, oils such as pyridine and Benzol are added to give it a disagreeable odor and some coloring matter such as methyl violet is often used. Wood alcohol is injurious to the skin to a certain extent, and therefore this mixture cannot be safely used either externally or internally on the person. The extent to which wood alcohol is injurious to the skin is governed by the characteristics of the particular person to whom it is applied, some people being more susceptible than others.

In order to have alcohol which cannot be taken internally, but which can be used safely externally on anyone, a very small fraction of tartar emetic, or formaldehyde, is added to grain alcohol, making what is known as medicated alcohol.

Hydrogen Peroxide

(1391) Raymond E. Carlson, Truman, Minn., asks:

Q. 1. How is hydrogen peroxide made?

A. 1. If you wish to make hydrogen peroxide, we would suggest that you agitate a quantity of barium binoxide in dilute sulphuric acid. The result will be H_2O_2—a very unstable product.

Q. 2. Compare the force of explosions of H_2O_2 in liquid form and H_2 and O_2 in gaseous form.

A. 2. The liquid, H_2O_2 will not explode but will gradually decompose.

Q. 3. How strong a current is necessary for the electrolysis of water, and need anything be added to pure H_2O before it can be separated into its component parts by electricity.

A. 3. It is not a question of current but of voltage; two volts will electrolyze water very nicely; the intensity of current merely governs the rate of decomposition.

It will be necessary to add some acid, alkali or salt to water before decomposing it by electrolysis; and a small quantity of sulphuric acid is often used.

Vacuum Cleaning Furniture

(1392) J. Birchall, Vancouver, B. C., Canada, wants to know:

Q. 1. Is there any machine on the market that will clean upholstered furniture, tapestries, etc., by suction?

A. 1. Any up-to-date vacuum cleaner should be able to clean upholstered furniture and tapestries. In fact, most of the vacuum cleaners on the market today are supplied with special nozzles for this work. The names and addresses of these companies may be found in the advertising columns of this and other magazines or may be had on receipt of a stamped self addressed envelope. Restate your inquiry when writing.

Formica

(1393) Noal W. Brown, La Roy, Ill., asks:

Q. 1. Please tell me how to make the composition known as formica.

A. 1. It is beyond the scope of the average amateur mechanic to make a composition similar to formica. Compositions similar to this may be formed by mixing together paper pulp, and some form of insulating compound such as shellac or sealing wax. This is subjected to heat while being mixed so as to thoroughly impregnate the paper pulp with the insulating material. The resultant mixture is then placed in a press and subjected to a very high pressure. The presses are made in various forms so as to turn out various shaped articles, such as panels, knobs, insulators, etc. The wax or shellac may be mixed when in alcoholic solution.

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Partial List of Contents

*Woman's Error and Her Debt.
Two Classes of Women.
Cries of Despair.
*When Should a Woman Avoid Having Children?
Birth Control—A Parent's Problem or Woman's.
*Continence—Is it Practicable or Desirable?
*Are Preventive Means Certain?
*Contraceptives or Abortion?
Women and the New Morality.
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☐ Better Letters
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☐ Business English
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☐ Common School Subjects
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☐ Machine Shop Practice
☐ Railroad Positions
☐ Gas Engine Operating
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☐ Architect
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HAST MAILING CO., Paducah, Ky.

Talking Newspaper

By CLYDE FITCH

(*Continued from page 858*)

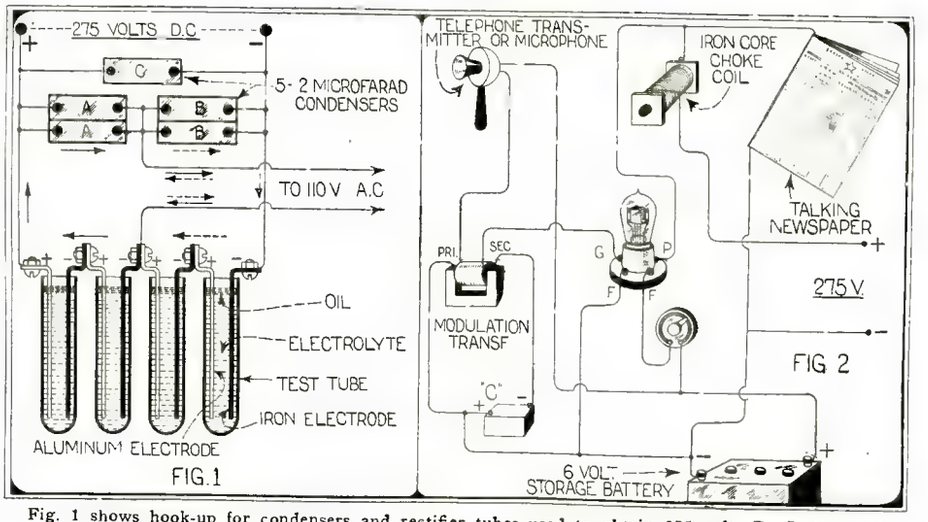

Fig. 1 shows hook-up for condensers and rectifier tubes used to obtain 275 volts D. C. from 110 volts A. C. without a transformer. Diagram at Fig. 2 shows how microphone is hooked up to talking newspaper, with audion, battery, modulation transformer, et cetera.

voltage at which they are charged. Since the voltage is fluctuating, corresponding to the vibrations of the human voice, the tinfoil sheets will vibrate, and reproduce the human voice.

The rectifier tubes and condensers may be arranged in a neat box, making a compact unit that will deliver about 275 volts D. C. direct from the 110-volt alternating current lines. The action may be explained as follows: Assume the first half cycle of the alternating current wave takes the path shown by the full line arrows. This will charge the condensers "A" to the maximum value of the alternating current voltage, which is 110 x √2, or 154. The next half cycle will take the path shown by the dotted arrows. This will charge the condensers "B" to 154 volts. Since condensers "A" are connected in series with condensers "B" the voltage across both condensers will be 2 x 154, or 308. But there is a voltage drop across the rectifier tubes due to the resistance of the electrolyte, and also a current leakage through them, so that the output voltage will be reduced to about 275. The function of condenser "C" is to help filter or smooth out the resulting pulsations, and hold the voltage constant.

It will pay anyone to make up this rectifier, as it can be used on your radio amplifier and will increase the volume of sound from your loud speaker a hundred times. Most amplifying tubes will stand voltages up to 400 on the plate, but a 5 watt-power tube may be used if desired, and the filament may be lit with alternating current without objectionable hum. Care should be taken in using it, however, as one side of the 110-volt line is grounded, and if the filament of the amplifier tube is grounded there will be a short circuit. This will do no harm other than to make two of the rectifier tubes boil over. The filament circuit of the amplifier tube should be insulated from ground by using a condenser in the ground lead. This is unnecessary with a double circuit tuner where the antenna circuit is coupled to the detector circuit.

To make a talking newspaper, the newspaper must first be prepared by inserting two sheets of light infoil between the sheets of the paper. The tinfoil may be taken from an old or punctured paper condenser similar to the ones used in Figure 1. The tinfoil sheets may be glued in one or two places to prevent them falling out, or the paper may be folded. In either case, the tinfoil should be assembled loosely, so that it will be free to vibrate. The tinfoil sheets should be insulated from each other by one page of the newspaper, and then connected to the amplifying equipment by means of two small insulated wires. This makes a condenser out of the newspaper.

Stream of Water Lifts Itself

(*Continued from page 859*)

the operating chamber and by virtue of the air-conducting pipe extends also to all the higher closed tanks. The result is that the water in each open tank, these being now full, is sucked up one step into the next higher closed tank. At the end of this suction stroke the operating chamber and the open tanks are empty, while the closed tanks are full of water. The inlet from the head-race then automatically opens, pressure-water is admitted into the operating chamber, and a new pressure stroke starts, the cycle being then repeated as before. The pipes between the tanks are all water-sealed, so that no non-return valves or mechanical checks are needed.

It will thus be seen that the air-conducting pipe transmits the actuating agent from the operating tank where it is developed. As compressed air on the pressure stroke, this agent forces water up one step from the closed to the open tanks, and then by vacuum action on the suction stroke it draws the water up one further step from the open to the closed tanks. The height required is reached by carrying the series of closed and open tanks, together with the air pipe, to the desired level. The system is equally effective at high and low lifts, and at no point are there more than a few pounds of pressure per square inch, whatever the height of delivery. With a working head of six feet, for example, the maximum pressure is less than two pounds per square inch. The normal efficiency of the apparatus is put at 80 per cent.

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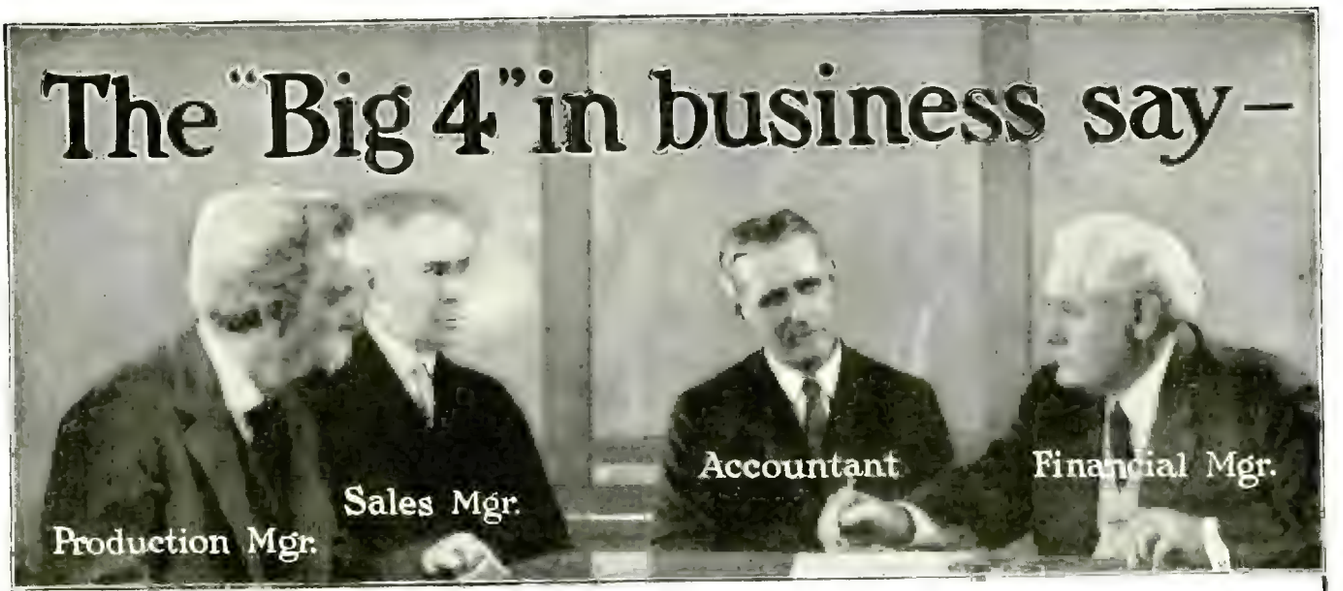

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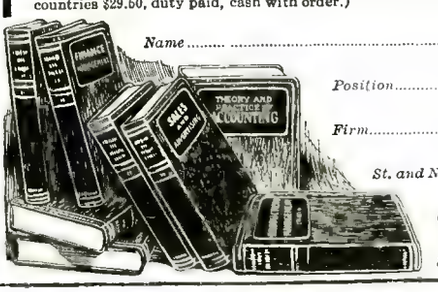

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Future Wars and the Long Range Gun

By NOEL DEISCH

(*Continued from page* 844)

The outstanding problems to be met in designing a supercannon result from the huge length that it must have to give the necessary velocity to a prejectile fired from it, and consequently the very considerable difficulties in manufacture, in mounting, and in handling.

Let us first consider the question of length. A modern 45 calibre, 12 inch gun giving a velocity to its projectile of, say, 2,500 feet per second, is roughly 50 feet in length. The Bertha was only about 85 ft. long, and the high velocity attained despite its comparatively short length resulted from two facts; that the diameter of the projectile was reduced to 8 inches, and that the explosive pressure of the charge was very considerably increased. The length of the cannon does not increase in the same ratio as the velocity of the projectile it fires, but much faster than this velocity. But let us assume that the cannon we have in mind would be as much as 500 feet long.

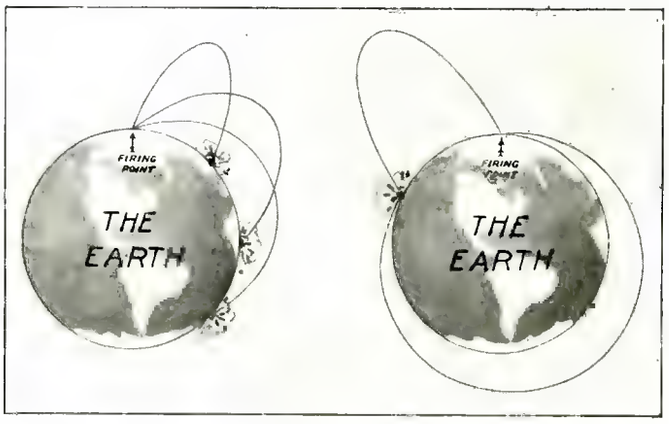

Fig. 2. At left: are shown the paths that would be followed by a projectile fired from the super-cannon described in this article. The left drawing shows the paths of shells fired at a velocity of 25,000 feet per second and aimed so that they will land on a spot one-quarter, one-half, and three-quarters of the distance to the antipodes. The right-hand drawing shows that if the projectile were fired at a velocity greater than 25,000 feet per second it would be possible to hit the same spot on the earth by firing in opposite directions.

It will not take any great exercise of the imagination to see that a gun of such length built to the usual proportions would be quite out of the question. It would be extremely difficult indeed to build up a structure of steel tubes fitted concentrically around each other after the method commonly used in making big cannons. Moreover, even if such a gun were made, it would inevitably droop considerably, and "whip" when fired, in a way that would be destructive of all accuracy. We cannot therefore merely copy on a larger scale the cannons we see reaching out gracefully from the turrents of our battleships, but must hit on something more in line with everyday mechanical practice. When this is done, we will have a machine whose appearance is quite as unmilitary as the "peach basket" masts of our warships are unshipshape, and which will be as much more efficient than the orthodox cannon, as our present unsightly masts are more efficient than their neat cylindrical predecessors.

The present smooth tubular form of cannon is a direct descendant of the "pedereros" and "culverins" of our romantic ancestors, who attached as much importance to art in the instruments of war as in the paraphernalia for any of their other athletic diversions, and in all but one particular it is about as ineffectively designed as it well might be. In the first place it lacks proper girder strength, that is, it is not stiff enough to remain absolutely straight in firing position under its own weight. Then again the longitudinal stresses set up in the material of the gun by the explosion-pressure acting on the breech plug, and the tangential stresses due to the radial pressure on the walls proper, act through the same body of steel. The sole way in which the present design of cannon excels is in its resistance to the tangential stresses just mentioned, in all other respects it will have to be redesigned when enlarged to the dimensions of a supercannon.

We start then with a tube, 500 feet long, say, and with walls just thick enough through all their length to carry with safety the pressure of the explosion, but with no metal added to support the tube, or to keep it straight. We may imagine this tube cast in one piece of high-manganese steel or some similar tough casting alloy, for it could not very well be built up out of concentric tubes, following the present practice.

Of course this tube must be supported at intervals along its length. And this would be done by the same means that engineers have developed to support any other heavy object, that is, nothing more mysterious than a good stiff steel truss. The forces acting on the base plug would be conducted from it directly to the trunnions by longitudinal steel tension rods, thus entirely relieving the tube of all stress except that which it was its own business to carry, that is, radial stress resolving into tangential stress alone. To make the gun movable so that it could be sighted, the barrel portion would move in altitude on oil-supported trunnions, and the whole would move in azimuth on a huge oil step-bearing mounting.

But give a moment's consideration to this fact. A projectile fired from any of the types of gun that we have been using in wariare throw their prejectiles through a gas called the atmosphere, and the atmosphere is a very solid body when things move through it fast enough. It acts on the flight of the projectile in so many ways that it would be tedious even to set them down, but the net result is that the projectile falls upon the earth at a spot far removed from the place where it would have fallen if the air had not been there.

Our supercannon projectile on the other hand would be going through the air only during those very few seconds that it consumed in penetrating denser part of the earth's mantle or air; in all the rest of its journey it would be traveling through a partial vacuum where it could not be shoved out if its proper path unless it chanced to bump into

(*Continued on page* 896)

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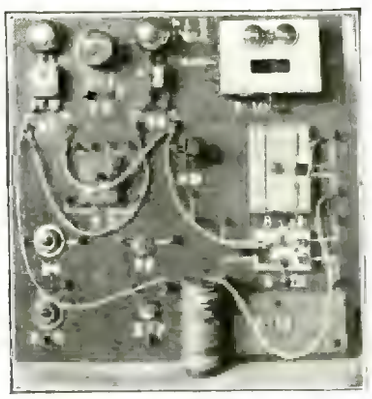

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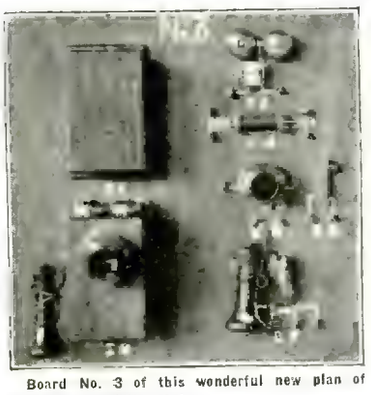

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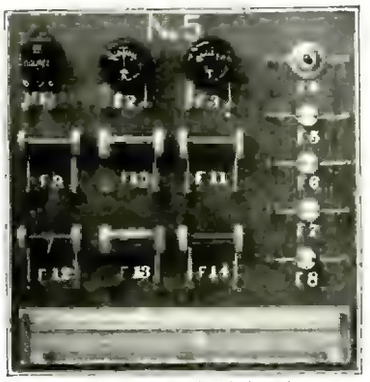

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Future War and the Long Range Gun

(*Continued from page* 894)

some stray meteor. That chance would be vanishingly small, but if the collision did occur we wager that the meteor would get the worst of it, because most of them, as astronomers claim, are not loaded with a charge of T. N. T.

It is evident then that if the projectile were aimed correctly it would go on the right path. A simple calculation will show that the bore could be ground with the exactness necessary to assure that the projectile would start off in a determined straight line, and with a powder charge adjusted to give the proper pressure to a degree of accuracy that would permit a shell to be dropped within the vast environs of a modern city from a point located a quarter of the way around our globe.

Of course, some nice problems of ballistics would be left over to divert artillerists during their leisure hours. A concrete example will make this plain. It can be shown that it would take a projectile fired at the most economical velocity 33 minutes to go from the pole to a point on the equator. But during those 33 minutes the earth would have turned about five hundred miles eastward from the point aimed at. The difference could be compensated for very easily in this specific instance by aiming the cannon at a point 500 miles west of the target. However, if the cannon were set up at any other point on the earth than at one of the poles, which it certainly would be, the earth's rotation would hatch out some delightful problems in spherical trigonometry. It may be noted that the path followed by the projectile would be such a curve, as is shown in one of the accompanying drawings. This would mean that if it were attempted to shoot at some belligerent located exactly on the opposite side of the globe, the shells would enter the atmosphere there at a grazing angle, and hence it would be very hard to do accurate shooting under such conditions. On the other hand, if the enemy's stronghold were obligingly situated about a quarter of the way around the globe, the shells would fall in at an angle of about 22 degrees, not very far from straight down. Nearer points would prove even better targets.

But what nation would, in this enlightened age, permit itself to bombard a helpless city? Well, just that *has* been done, by a people who will be glad to prove on demand that they are the most "kultured" people who have up to date made war.

But now let us turn over the sheet and view the converse of the question. Suppose that we ourselves should erect a number of these huge engines, space them thinly over the expanse of our western plateau, where they would be difficult of access to an outside enemy, and hard to hit by other supercannons, and where due to the great altitude a much less dense body of air would have to be passed through by the projectile as it mounted from the earth. Without doubt these silent monsters would put us in a position to do some quiet but effective speaking in a diplomatic discussion. The positive knowledge by the world that we would be in a position to pelt any part of this planet with a devastating hail of high explosive shells within an hour after a declaration of war, and that we might do it in entire security as regards the safety of the siege pieces, and continue to fire at a rate limited only by the capacity of our factories to manufacture ammunition to feed them, would likely occasion a little pensive reflection on the part of Emperors and diplomats before they set signature to the document that would forthwith bring war to their very housetops.

Burning Water

(*Continued from page* 855)

match to it. In about two minutes the water which remained in the coils was brought up to its boiling point, and a quantity of steam was forced out of the nozzle of the coils themselves. The inventor then grasped the valve leading to the oil supply and opened it. Due to the siphonic principle embodied in the construction of the nozzle, the oil was sucked up by the action of the steam and sprayed, in finely divided form at the coils. The water was now turned on and with the exception of a few splutters, the flame burnt steadily. Within four minutes from the time it had been started, the heat developed was so terrific that it was necessary for the writer to move away from the door of the furnace. The roar of the flames was quite noticeable in the small closed room but not objectionable. The blue area about six inches from the nozzle of the gun became pure white when it reached the coils. The temperature attained by this furnace was 2,200°F.

Many investigators have claimed that the efficiency of this furnace is to be doubted, as it will require just as much energy to bring up the water to the high temperature, consequently causing a loss here, as it would to burn the oil in a pan. These statements, according to the inventor, do not bear fruit. Remsen's figures give the number of British thermal units in one pound of water when converted into water gas, as above 68,300, and we know that after steam mixed with hydrocarbons has been heated to a sufficient degree water gas will be produced, a true gas, a mixture of carbon monoxide and hydrogen. Of course at this temperature, it is impossible to separate the gas, and it is even quite difficult to do so at the temperature of 1600° F., but the inventor of this process does not attempt to separate the gas and burn it. He mixes this gas with oil which forms a carbon gas. One can tell the moment that the water is turned off, because the heat immediately diminishes. There is no smoke or soot in the flames whatever, no carbon deposit can be found on any part of the furnace after the same has been in operation for a few minutes. Should the water supply fail and the tank run dry, the furnace automatically shuts off, and no damage can result, because when steam stops, the siphonic action no longer takes place, and the oil supply automatically ceases. Check valves in both the water and oil supply leads prevent any backward action. The inventor claims that the steel helical tube in his device prevents any moisture being carried in the water, because as the steam courses through these pipes, being heated to a higher temperature, 900°, it gains in velocity, any particles of water vapor striking the hot surfaces of these pipes is immediately converted into steam, which is in turn changed to water gas.

Experimental Electro-Chemistry

By RAYMOND B. WAILES

(*Continued from page* 871)

with water acidulated with sulphuric acid. The battery and the ammeter which is to be checked for accuracy, or the home-made ammeter which is to be calibrated, is placed in series with the gas voltameter. A variable resistance can be used to cut down the current strength so that the entire scale of the ammeter can be checked or calibrated. The pinch cock at the upper end of B is opened and the screw clamp at the bottom is adjusted so that the water in tube B is at the zero mark (top). The spring clamp is then released, *i.e.*, closed. When the levels of the water in tubes A and B are the same, as shown by the smaller insert figure, with the spring clamp open, the instrument is ready to use. The spring clamp must be closed during the operation of the instrument, and the screw clamp must be open.

Turn on the current from the battery, with watch in hand, when the minute hand passes a known second mark. Note the ammeter reading and record same. Allow the water to be split up into its constituents for a length of time which is determined by the capacity of the burettes.

Turn off the current and note the exact number of seconds the current has been on by reference to the watch. Hold the tube A level with tube B and lower it until the levels in both tubes are at the same height as shown in the small insert. Read the cubic centimeters of gas in the burette B.

The calculation is as follows.

$$I = \frac{cc}{\text{number of sec} \times .173}$$

Here, I is the strength in amperes. cc the number of cubic centimeters of gas evolved (the reading of burette B). If the ammeter is correct, its reading will correspond exactly with the figure found in the above formula, when solved.

The hydrogen and oxygen gas generated mix and pass up the tube T, into the burette B, displace the water in same, which is backed up in burette A. When the tubes are levelled, the pressure exerted by the column of water in A is corrected to normal conditions. This feature has not been incorporated in many forms of gas voltameters.

It has been observed that one ampere of current flowing for one second will liberate .173cc of oxy-hydrogen gas, thus the formula is readily derived.

WEIGHT-VOLTAMETER

Instead of liberating gas and measuring the volume, the current can be made to deposit metal, which metal is to be weighed.

The weight-voltameter, which operates on this principle, consists of two brightly polished copper plates which are weighed on a sensitive balance and afterward placed in a solution of copper sulphate and connected with several cells, the ammeter to be checked is placed in series with the whole. The current is passed as usual. After the test, the plates are removed, well washed and dried, then weighed. The negative plate will be found to have increased in weight, while the positive plate will have lost. The weights exactly counterbalance since the copper changed from the solid state on the positive plate and went into solution, while the copper in the ionic or solution (copper sulphate solution) state changed into molecular, or plated out upon the negative plate, thus causing it to gain in weight. As a balance of high sensitivity is required, this method is little used in non-professional instrument checkings.

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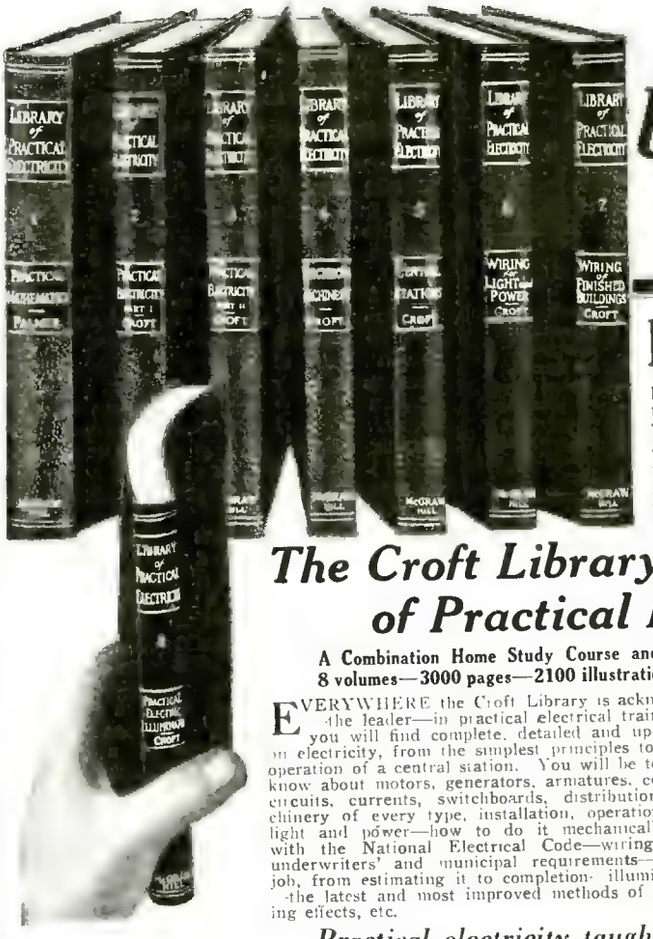

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Movies That Talk

(*Continued from page 847*)

of the WGY announcer "KH" was recorded on a photographic film and sent out by WGY with such accuracy that it was impossible to distinguish it from his voice as ordinarily directly transmitted from the station.

THE SEIBT SYSTEM OF TALKING MOVIES

The method which Dr. Seibt, the German scientist, uses, involves the use of a gas-filled glow tube. Here there are again several variations. It is very usual to employ a Gehrcke tube; if the Gehrcke tube is fed with a constant current, if the cathode only is used, one will obtain on the film in unbroken condition a black band, whose height may be made to extend if desired, to the center. This continuous band changes in form when the voice waves affect the light waves at their source, in the way shown in Fig. 1. When thus obtained the band is of varying height, and by the difference in height the characteristic of speech, especially of music, is produced and reproduced, as desired.

Another possible source of light consists in a glow light tube (like a bulb), which contains a proper amount of nitrogen and has a capillary connection as shown in Fig. 4. Nitrogen is chosen because it gives specially actinic rays of light when in the incandescent stage. The capillary form is selected, for by this means an extraordinary concentration of light is obtained, which is especially desirable for the talking film, namely, from a light unit in the form of a straight stretched thread. The difficulties which formerly applied to the use of an incandescent lamp are avoided by the use of this capillary source of light. A potential of about 800 volts is needed to supply the glow light tube, the same as was required for the Gehrcke tube, and an excess of potential is disposed of in the resistance and choke tube in parallel. It is desirable for these latter, D in Fig. 4 not to be too small, because the tube will burn more steadily. The use of a charge of gas in the bulb as the source of light has an advantage over the filament lamp, as the smallest variations are converted into variations of light, so no smoothing down of the voice waves is to be feared. Acting in the opposite way to the Gehrcke tube, the glow light tube gives a dark streak with variations in intensity, but no difference in amplitude.

The optical system presents no special difficulties. Seibt found that it was not necessary to use cylindrical lenses, but rather a good photographic objective was the thing. To change the voice waves into electric waves, a microphone of high frequency was originally used, but Seibt soon parted from this and used a telephone of high internal frequency to strengthen the undulations produced. The reason for abandoning the use of the microphone was that it was affected by agitation of its structure much more than was a telephone.

A four-tube amplification is quite sufficient to strengthen the voice waves, to such an extent that they will affect the source of light sufficiently at a distance of four to five meters. The use of a photo-electric cell for the reproduction in place of a selenium cell, appears first to have been suggested by Siegmond Loewe (1918), in whose apparatus the photo-electric cell was directly connected to an amplification apparatus. This improvement produced irrespective of its applicability for talking films, a photograph of greater capability, which surpasses the modern plate apparatus in purity of tone and reproduction, length of reception, and ease of reproduction materially. The photo-electric cell has the great advantage that it works practically free from lag. The connection with the amplification apparatus can, on account of its high resistance, be made without a preliminary transformer. In reproducing, it is natural to see that the lighting of the film takes place when the film is not moving backwards but when moving evenly. In making the exposure, care must also be taken with the source of light, so that the photophonic image shall be set a little to one side of the objective. The perfectly even travel of the film can naturally be obtained by the regular methods already known. As the variations in the light reproduced in the electric current are proportionally weak, they must naturally be amplified before they are brought into the telephone. A five-tube amplification is sufficient for this purpose. Naturally we must take care that the amplifier on its side works quite free from any influence. Among other things, care must be taken that the last of the tubes should be driven with sufficient energy for all intensities, and one should work on the straight part of the characteristic graph. Strong negative grid potentials up to 8 volts have proved favorable in strong tubes. For the coupling of the tubes among themselves,

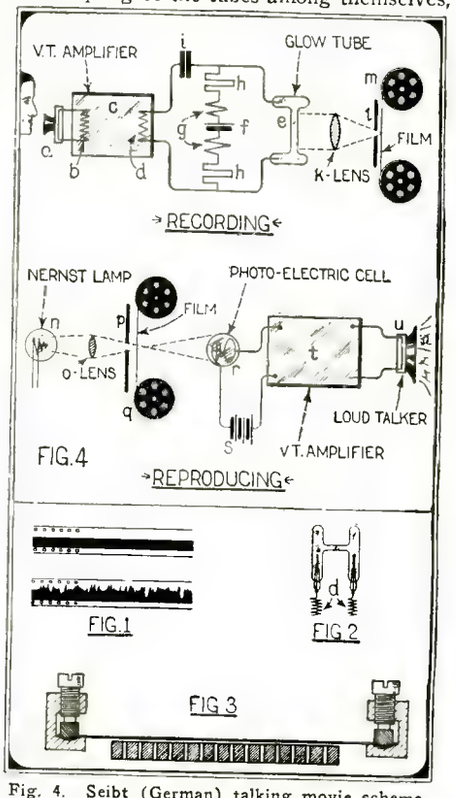

Fig. 4. Seibt (German) talking movie scheme. Above:—Recording apparatus: Below:—Reproducing apparatus.
Fig. 2. Capillary or glow glimmer tube.
Fig. 3. George Seibt's electrostatic telephone.
Fig. 1. Speaking film according to G. Seibt. Above—voice unrecorded; below—voice recorded.

transformers or ohmic resistances are used. The latter have the advantage that they have no periodicity of their own, so that no deterioration of the voice waves results. If transformers are used, they must be strongly dampened; they must be chosen of such high natural periodicity, that the frequency exceeds the vibrations of the human voice; in other words, over 2,000 per second. If music in the high scale is to be reproduced in purity, the natural periodicity of the transformer must be about about 4,000 per second. The ear can transfer to the brain much higher frequencies than these.

The fundamental idea of Seibt when he encountered this problem was to eliminate everything which could bring about a deterioration in the purity of the vocal sounds, and this also led him to select a special re-

(*Continued on page 916*)

Dr. Hackensaw's Secrets

By CLEMENT FEZANDIÉ

(*Continued from page 853*)

"A little of it would do me a lot of good," remarked Silas, whose pocketbook was always empty.

"Silas," said Doctor Hackensaw, solemnly, "I am now able to manufacture gold in any quantity I desire, at the cost of a few dollars per ton. And yet I am not going to make any more of it, because it would be a bad thing for the world if gold were produced in large quantities. Gold is now very valuable as currency, or as a means of exchange between nations. If made in quantities it would be useless for this purpose, and its value for other purposes would by no means compensate for this loss. Cheap silver would be very useful for the manufacture of electric wires, because silver is a better conductor of electricity than copper. But gold, though it would be useful as a lining for kitchen utensils and other purposes of the sort, would be of small use in the arts, no matter how low the price. The benefits derived from an unlimited supply of gold would not begin to make up, for mankind, the loss of gold as money or a means of exchange.

"Then, too, the manufacture of gold on a large scale, would bring about a financial crisis, such as the world has never before experienced. The present financial conditions in Austria and Germany will give you some idea of what would happen. Why, I had not sold a million dollars' worth of my synthetic gold before I was visited by confidential agents from the different governments of the world, begging me to desist unless I wished to be the ruin of hundreds of thousands of families."

"I can't say that I understand you, doctor?"

"It is possible? Why, you see, all our bank-notes are on a gold basis. And all bonds, loans, rentals, contracts, et cetera, are made either on the basis of bank-notes or of gold. Now gold, at present, is worth nearly *twenty-one dollars an ounce*. If I manufactured it at *twenty-five cents per pound*, it would be worth only one one-thousandth of what it is at present. In other words, a man having a thousand dollars in bank-notes, bonds, money in the bank, or other credit, would find he could buy only *one* dollar's worth of goods with it. The contractor would have to fill his contracts at a cost a thousand times greater than he had figured on. Creditors would lose practically all the money owed them, while all debtors would benefit by having the greater portion of their debt cancelled."

"In that case," remarked Silas, "it would seem to me that it might not be a bad thing for humanity at large—the rich would lose, but the poor would gain!"

Doctor Hackensaw gave him a pitying look. "Yes," said he, "that is the Socialistic argument. Take the capital away from those who have it, and distribute it among those who lack it! This is a comparatively easy thing to do, but the fallacy is that the capital, thus divided, would be soon dissipated. At the same time, the incentive to form new capital would be destroyed and the world would revert to a condition little better than savagery. It is capital that makes civilization possible. But enough of this lecture. Of course I agreed at once to stop making gold, and to change all I had in stock back into lead again."

"And you really possess the power of changing one element into another in this way?"

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"Yes. I have been working on the problem for the past thirty years, and had solved it theoretically years ago. The decomposition of the elements is merely a question of obtaining sufficient heat. Heat is the real 'Philosophers Stone.'"

The reporter looked incredulous.

"Yes, continued the doctor, "The spectroscope shows us that the sun and the stars, which are at a very high temperature, possess elementary substances very rare on the earth. As our earth at one time formed part of the sun, the inference is plain. Many of our common elements must have been changed into some other form in the sun; in a word, the heat must have decomposed them into simple elements. And analogy would lead us to believe that a still greater heat would decompose those elements still existing in the sun."

"I don't see how mere heat can make such a change," hazarded the reporter.

"The heat forces the particles of the atom further apart, and thus sets them free to form new combinations. When the electrical furnace was invented, I thought my problem was solved. But the temperatures obtained are far inferior to those needed. Of late methods have been found for obtaining an exceedingly high temperature for a duration of a second or so, but, of course, such *explosions* of heat, if I may so call them, are unsatisfactory for practical purposes. What I required was a continuous heat at a hitherto undreamt-of temperature—and I obtained it!"

Here Doctor Hackensaw paused, then continued after a moment: "The tremendous amount of energy required made coal too expensive as a source of power. I accordingly use wave-power, transformed into electricity. This electricity I 'step-up' or 'boost' to inconceivable voltages or amperages, as I desire, and then change this electricity into heat of temperatures so high that the figures would mean nothing to you. A special form of audion that I have devised forms part of my apparatus and aids in intensifying heat, just as the ordinary audion amplifies sound—for heat, like sound, is nothing but a vibration.

"To change my electrical current into heat, I use, as a resistance, the vapor of the element that is to be decomposed. Thus, if I am decomposing lead, I first vaporize the lead and then pass the electric current through this vapor—the vapor forming the resistance. The tremendous heat obtained separates the atoms of lead into atoms of simpler elements, and by removing those that are not desired and bringing together in their nascent state those which I wish to combine, I am able to manufacture any element out of very cheap materials. For instance, gold, as I have told you, is merely lead with two atoms of helium removed. Hence, after raising my lead to a temperature sufficient to decompose the atoms, I remove the helium, and the remaining gases when cooled, combined to form gold. It is still easier to change the gold back into lead again, for I merely add the right quantity of helium vapor to the gold vapor, then heat both together, and when cooled I have lead instead of gold."

Silas made a grimace. The idea of changing *lead* into *gold* evidently did not appeal to him.

Doctor Hackensaw continued: "At first I used temperatures much higher than were really necessary. I have found that under certain conditions the atoms will dissociate or decompose at much lower temperatures than others. A high frequency current, for example, seems to set the elementary particles of the atoms vibrating at greater speeds—at any rate, it enables me to dissociate the atoms at greatly reduced temperatures. Ultra-violet rays also help, and combination is also sometimes useful, that is to say, the joining of another gas to the one I wish to decompose."

"But, doctor," objected Silas, "what will be the use of your apparatus if you cannot make gold?"

Doctor Hackensaw smiled. "Silas," said he, "I'm going to make the most precious element that exists—one that has an intrinsic as well as an artificial value."

"And what is that?"

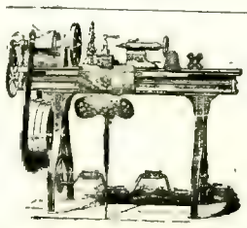
"Radium!" replied the doctor. "All this worthless gold here will be transformed into radium."

"And what will you do with all that radium? It won't be worth anything if you make too much of it."

"You think so, but you forget the energy stored up in radium. A gram of radium gives off thirty-six billion helium atoms per second. If you don't believe me you can count them for yourself! In doing this it liberates a large amount of energy. It has been calculated that a gram of radium, in turning into lead,—as radium naturally does in time,—gives out some *three* million horsepower hours of energy. In other words, if it takes twenty years for the radium to throw off enough helium particles and become lead, (and I have found means of hastening this natural change), six grams of radium will be sufficient to run a one-hundred horse-power automobile continuously, day and night, during the whole twenty years.

"But I do not use the radium only for running automobiles. It is useful for all purposes where a motive power is required. Like electricity, it is a source of energy, and there is practically no limit to the uses to which it may be put. It may be used to produce heat, light, or power, at will. It is compact and easy to carry—the six grams can be put in your coat-pock even allowing for the bulk of the special radium-proof containers I have invented. Your automobile may be as light as a buggy, because it requires no engine. You place your six grams of radium in the machine, turn a lever, and off you go!

(*Continued on page* 905)



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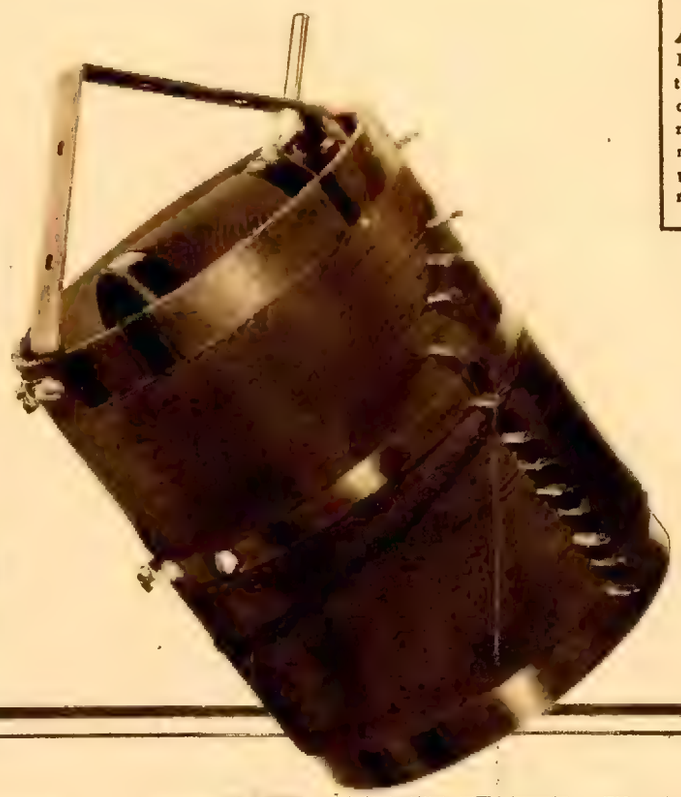

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This second edition of his work is now coming off the press. It has been highly commended by newspapers and has been approved and recommended by "Literary Digest," "N. Y. Evening Mail," "Washington Herald," "Atlanta Journal," "Newark Ledger" and others. "Radio News," "Pacific Radio," "Q. S. T." and other radio magazines have also approved the work of Mr. Harkness.

It has been acclaimed as the only authentic source of information on the subject, "A fine contribution to the advancement of radio," "Instructions that translate the complications and bring the application of the new circuit within the grasp of all."

The booklet contains full theoretical information, with explanatory diagrams.

30 WIRING DIAGRAMS
MECHANICAL DRAWINGS
and PHOTOGRAPHS
PRICE 50 CENTS

"MULTI-RANGE"

Bank Wound Coupler

Passed the strict requirements of the RADIO NEWS LABORATORIES and awarded their Certificate of Merit.

Pronounced by the "N. Y. Evening Mail" Laboratories as "the finest bank wound coupler produced" and awarded their Certificate of Excellence.

Scientifically designed by experts, the "MULTI-RANGE" Coupler permits the easy construction of an efficient short and medium wave receiver at low cost. Wavelength Range 150 to 3,400 meters.

SPECIFICATIONS

Bakelite Tubing; green double silk covered wire, wound by hand and moisture proofed; heavy nickel-plated metal parts; convenient solder taps; 180° coupling; Litz wire rotor leads.

List Price—$11.00

DEALERS—The Multi-Range Coupler is widely advertised. Write for special discounts.

The Radio Guild, Inc.

256 W. 34th Street — New York, N. Y.

Experts in radio frequency amplification.

Designers and manufacturers of the "Vox Humana," the R. G. 510 and the "Dashboard Special."

BUILD YOUR SET WITH BARAWIK STANDARD

PLATE CIRCUIT "B" BATTERIES

You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.

A180 Signal Corps type, small size, 15 cells, 22½ volts. Each....95c

A182 Large Navy size, 6½x4x3, 15 cells, 22½ volts Each.....$1.75

A184 Variable Large Navy size, 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each.....$1.80

A186 Double Navy size 6½x4x6; 30 cells, 45 volts. Suitable for amplifier circuits and power tube use. Two or more of these units in series may be used in C. W. and radiophone circuits. Each.....$3.40

A188 Combination Tapped 45 volts, 30 cell, 6½x4x6 battery. Tapped to give 45, 22½, 21, 19½, 18 and 16½ volts. Handles both detector and amplifier tubes. Each.....$3.55

WILLARD "B" STORAGE BATTERY

Better results. No battery noises. Cheaper in the long run. Easily recharged by our Battery Charging Rectifier. Leak proof glass jars. Will last for years.

A205 Price.....$9.00

BATTERY CHARGING RECTIFIER

Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips.

Prices F. O. B. Chicago. Transportation Paid.

A201 For 6 volt battery.....$13.95
A203 For 12 volt battery..... 13.95

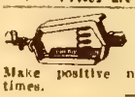
STORAGE "A" BATTERY

A very high grade battery made especially for radio service. Guaranteed for three years. Properly cared for will give many more years of service for filament lighting. Made of best new materials. Full capacity. The best battery buy on the market.

A194 6 volt, 40 ampere size. Each....$10.00
A196 6 volt, 80 ampere size. Each....$12.50

Prices are Transportation Paid.

BATTERY CLIPS



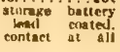
A198 Two for.....28c

Clip onto storage battery terminals, lead coated. Make positive non-corrosive contact at all times.

WIRE CONNECTING CLIPS

A199 Per dozen.....30c

Small connecting clips for fastening leads onto binding posts, etc. Handy and useful. Every radiofan should have at least a dozen.



PORCELAIN BASE SWITCHES

Fine white porcelain bases. Copper contacts and blades. Can be used as antenna switches.

A385 Single Pole Single Throw. Each.....20c
A387 Single Pole Double Throw. Each.32c
A384 Double Pole Double Throw. Each.50c

FILAMENT CONTROL RHEOSTATS

Cresley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.

A130 Each.....45c

Best Grade. High heat resisting base. Diam. 2¾ in. cap 1½ amp. Resist. 6 ohms. 1¼ in. Knob with pointer.

A132 Each.....46c

POTENTIOMETER

Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 200 ohms.

A133 Each.....$1.05

VERNIER RHEOSTAT

Gives exceedingly fine control of "A" battery current. A necessity for best receiving results.

A135 Each.....$1.19

QUICK ACTING VERNIER RHEOSTAT

Gives very fine control of current and can be switched on or off instantly at any desired point. A124 Each.....$1.38

Porcelain Base Rheostat for table mounting. Resist. 10 ohms.

A136 Each.....78c

RADIO TUBES

Tubes for winding coils. Strong solid wood fiber material, with smooth clean surface.

A950 Diameter 3 inches, per foot.....20c
A951 Diameter 3½ inches, per foot.....25c
A952 Diameter 4 inches, per foot.....30c

WE PAY TRANSPORTATION CHARGES EAST OF THE ROCKIES

THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

FAST SERVICE—TRY US AND BE CONVINCED

THIS GUARANTEE PROTECTS YOU—Examine the goods we ship you. They must suit you in every respect.. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

AGENT-DEALERS WANTED

We want Agent-Dealers to handle our line of goods in every locality.

Our Proposition Means Money to You

Our prices save you money. The quality of our goods insures satisfied customers. Our service will help you do a large business on a small investment.

SEND FOR OUR CATALOG

We have selected a line of goods—both completed sets and parts to assemble sets—that will enable you to supply the needs of all radio customers and make money. You can make a good income on our proposition with a very small investment.

It shows the merchandise you should handle, gives much radio information and will help you establish a successful business. Enclose 10c for the catalog. Tell us what you can and want to do, and how much you can invest. We'll do the rest.

For the Person Who Makes His Own Set

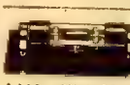
Our catalog is interesting and valuable. Even if you are not interested in radio as a business you will find many interesting things in this catalog and you will save money buying your supplies from us.

VACUUM TUBES

Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.

A105 Detector. Each.....$4.45
A110 Amplifier. Each..... 5.95
A118 5 Watt Transmitter... 7.70

MYERS TUBE



Can be used in Myers receptacle or in any standard socket with adapter listed.

A113 High-Mu Audion. Has 5 times amplification of ordinary tubes. Oscillates anywhere from 2 to 300 volts on plate. Each.....$5.00
A116 Receptable for above. Each....$1.00
A117 Adapter to adapt Myers tubes for use in any standard socket. Each.....$1.05

MYERS CHOKE COIL

Designed to work with Myers tubes. Brings in loudest signals. Flexible over a broad band of wave lengths. Free from amplifier noise and distortion. Mounts in Myers special receptacle.

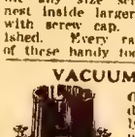
A119 For Audio Frequency Amplification.....$3.50
A120 For Radio Frequency Amplification.....3.50

FOUR-IN-ONE SCREW-DRIVER

A974 Each.....55c

Especially suitable for radio work. Will handle any size screw used. Smaller drivers nest inside larger one and are held in place with screw cap. Made of steel, nickel finished. Every radio builder can use several of these handy tools.

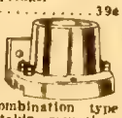
VACUUM TUBE SOCKETS



Our Special Socket. A wonderful value. Moulded entirely of bakelite. Four binding post connections. Right angled contact springs.

A140 Each.....39c

PORCELAIN BASE AND TUBE



A144 Cresley for either panel or table mounting.....42c

High Grade combination type for panel or table mounting. Metal tube. High insulation base.

A146 Each.....45c

Paragon combination type for panel or table mounting. One of the best designed and best made sockets on the market. Metal tube bakelite base.

A148 Each.....$1.10

TWO AND THREE GANG SOCKETS

These sockets make it easy to build detector and amplifier units and make a neat, compact workmanlike job. Perfectly made of high grade materials. Quickly mounted on panel or base.

A147 Two gang socket.....$1.20
A149 Three gang socket..... 1.65

FIXED CONDENSERS

Moulded cases, nickeled binding posts.

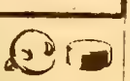
A804 Each.....48c

CARBON PRESSURE VERNIER RHEOSTAT

Current regulation is obtained by changing of pressure on carbon. This permits of infinitely fine variation of current. Very durable. Resistance 15 ohms. Capacity 2½ amperes.

A131 Each.....$1.65

VARIABLE GRID LEAK



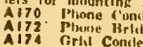
Pencil mark type. Resistance may be varied exactly as needed. A160 Each.....24c

GRID CONDENSER

A162 Mounting holes spaced to fit lugs of above leak. Cap. .00025 MF.....17c

A163 Same as 162 but higher grade. Enclosed in metal case.....39c

PHONE AND GRID CONDENSERS



A compact style of condenser that is very satisfactory. Conducting sheets and dielectric are wound on fiber strip with eyelets for mounting and connections. Each 12c

A170 Phone Condenser .001 Mfd.
A172 Phone Bridging Condenser .0005 Mfd.
A174 Grid Condenser .00025 Mfd.

A176 Grid Condenser .00025 with pencil mark leak. Each.....24c

TUPULAR GRID LEAKS AND CONDENSERS—MOUNTED STYLE

Very convenient. Permits quick change of leaks or condensers of varying capacities.

Grid Leaks. Price Each.....39c

Resistance		Resistance	
A850	.5 Meg.	A855	2. Meg
A851	1. Meg.	A857	3. Meg.
A853	1.5 Meg.	A859	5. Meg.

GRID AND PLATE CONDENSERS

Price, each.....55c

A830 .000025 Mfd. Correct for Myers Tubes.
A832 .0001 Mfd. For special circuits.
A834 .00025 Mfd. For U.V.201 and Cun. 301
A836 .0005 Mfd. For U.V.200 and Cun. 300.

MOUNTINGS

Bakelite base. Spring clip contact.

A840 Single mounting. Each.....32c
A842 Double mounting. Each.....57c
A844 Triple mounting. Each.....76c

"HONEYCOMB" COILS

Carefully made—fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm enamel impregnation. Range given is in meters when paired with .001 variable condenser. Mounted coils have standard plug mountings.

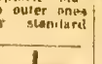
Turns	Range	Art No.	Not Mntd.	Art No.	Price Mntd.
25	120- 250	A301	$0.39	A320	$0.97
35	175- 450	A302	.42	A322	1.00
50	240- 720	A303	.49	A323	1.07
75	300- 910	A304	.54	A324	1.12
100	500- 1450	A305	.58	A325	1.16
150	600- 2000	A306	.63	A326	1.21
200	900- 2500	A307	.72	A327	1.30
250	1200- 3500	A308	.78	A328	1.36
300	1500- 4500	A309	.82	A329	1.40
400	2000- 5000	A310	.97	A330	1.55
500	2800- 6100	A311	1.12	A331	1.70
600	4000-10000	A312	1.27	A332	1.85
750	5000-12000	A313	1.43	A333	2.00
1000	7900-15000	A314	1.70	A334	2.38
1250	9750-19500	A315	1.92	A335	2.60
1500	14500-26500	A316	2.18	A336	2.76

COIL MOUNTINGS

A340 Three coil mounting.....$3.95

High grade fine looking mountings. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil.

COIL PLUGS



Made of moulded bakelite. Fits any standard plug. Mounts any standard honeycomb coil.

A344 Each.....80c

PANEL MOUNTING COIL PLUGS

Take any standard mounted coils. Made of moulded bakelite, mounted on brackets.

A335 Stationary. Each.....89c
A340 Movable with anti-capacity handle. Each.....$1.10

RADIO FREQUENCY AMPLIFYING TRANSFORMER

A995 Very special.....$2.95

This transformer will get the long distance stations loud and clear. Permits of easy sharp tuning. Helps cut out static and interference. Makes your set sensitive enough to use a loop aerial. Enclosed in metal case affording perfect shielding. Suitable for panel or base mounting. Because of its special design can be mounted in any V. T. socket. Works with any style of tuner. Wave ranges 150 to 550 meters. Wiring diagrams included.

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

As high as three stages can be used without howling due to proper impedence ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.

A234 10 to 1 Mounted. Each.....$3.69
A235 10 to 1 Unmounted. Each..... 2.95
A236 3 to 1 Mounted. Each..... 3.59
A237 3 to 1 Unmounted. Each..... 2.85

THORDARSON AUDIO FREQUENCY AMPLIFYING TRANSFORMER

An especially high grade transformer with correct characteristics for Cunningham, Radiatron or A. P. Tubes. Wonderful results without distortion on one, two or three steps. Low distributed capacity. Fully mounted bakelite panel.

A232 3 to 1 Ratio. Ea.$3.69
A233 10 to 1 Ratio. Ea. 4.25

RADIO CORPORATION TRANSFORMERS

Audio Frequency Amplifying Transformer. Especially designed for Radiotron tubes. 9 to 1 winding ratio.

A712 Each.....$6.40

RADIO FREQUENCY AMPLIFYING TRANSFORMERS

Range 200 to 3000 meters. For long distance reception.

A714 Each.....$5.95

OUR COMPETITOR AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

While these are very low priced transformers, nevertheless they will give excellent results. They are carefully designed and carefully made. Quantity production and small profits make the low price possible. They will equal in results many transformers selling at much higher prices.

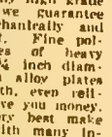
A238 Unmounted, with wire leads....$2.00
A239 Mounted, with binding post connections.....$2.75

BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS

A812 43 plate .00 Mfd. 2.35
A813 21 plate .000 Mfd. 1.90
A814 11 plate .00025 Mfd. 1.40
A815 3 plate Vernier..... 1.00

These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Fine polished end plates of heavy bakelite. Shafts ¼ inch diameter. Sturdy, heavy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with many inferior cheap condensers offered. We guarantee them to please you or your money back.

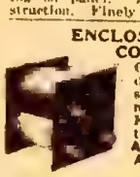
COMBINATION VERNIER VARIABLE CONDENSERS



A824 23 plate .0005 Mfd. with dial and knobs. Price....$3.25
A826 43 plate .001 Mfd. with dial and knobs. Price....$3.95

The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial mounted with a three plate vernier condenser, which is controlled by separate knob mounted above knob on dial. This arrangement permits of very fine tuning. Compact convenient mounting on panel. High grade design and construction. Finely finished.

ENCLOSED VARIABLE CONDENSERS



One of the best made condensers. Rigid, accurately spaced aluminum plates. Formica ends. Engraved scale. Knob and pointer. Clear transparent case.

A806 43 plate .001 Mfd.$3.95
A808 21 plate .0005 Mfd $3.25

KNOCKED DOWN VARIABLE CONDENSERS

You can save money by assembling your own condensers. Furnica top and base. Complete with all parts not assembled. Go together easily and perfectly. Panel moulding type.

A820 41 Plate .001 Mfd.....$1.95
A821 21 Plate .0005 Mfd..... 1.60

RADIO GOODS---DEPENDABLE QUALITY---LOWEST PRICES

PRESERVE THESE PAGES—ORDER FROM THEM AND SAVE MONEY
FAST SERVICE—TRY US AND BE CONVINCED

THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

THIS GUARANTEE PROTECTS YOU—Examine the goods we ship you. They must suit you in every respect. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

HOW TO ORDER—Write your Order plainly, state Article Number, Description and Price of items wanted. Send Postoffice or Express Money Order, Certified Check or Bank Draft for Total of Order.

ARLINGTON RECEIVING TRANSFORMER

Will tune in all stations up to 3,500 meters. Very efficient on short waves and for radio phone reception. Used with our Detector Two Step Amplifier it produces very excellent results. Also does good work with crystal detector. Silk covered windings on formica tubes. Very fine mahogany finish wood work. Base size 6x16 inches. Slider controls primary. 12 point switch on secondary. Can be tuned very close. A wonderful value at our price.

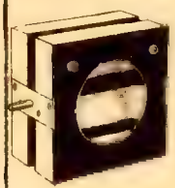
A720 Price $6.48

TUNING COIL

Range up to 950 meters. Wound with bare copper wire, machine spaced. Ends of mahogany finished hard wood. Two easy sliding contacts on polished brass rods, four binding posts. Substantial, efficient, attractive. Length, 8¾ in.

A722 Price $2.45

VARIOMETER

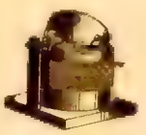


A410—Completely assembled, price $2.89

A411—Not assembled but all parts complete except wire, including winding form. $1.48

Perfect in design and construction. Accurate wood forms of genuine solid mahogany. Correct inductive ratios. Solid baked windings. Positive contacts. Highest efficiency. A real bargain.

VARIO-COUPLER



With this loose coupler and two variometers, together with the necessary other parts, a highly efficient tuning set can be made. Easily mounted on panel. Primary winding on formica tube. Inductively coupled for 180 to 600 meters. Multiple taps permit fine tuning.

A415 Price, completely assembled..... $2.45
A416 Not assembled, but all parts complete except wire. Price..... $1.18
A417 Rotor ball only. Each..... 29c
A408 Bakelite stator tube only. Each.. 35c

MOULDED VARIOMETER

Polished black moulded rotor and stator forms. Maximum inductance with greatest efficiency and minimum distributed capacity. A high grade durable instrument that will make up into a set you will be proud of and will get the best results. Wave length 180 to 600 meters. 4¼ in. square, 1⅞ in. thick.

A412 Price $4.25
A413 Brackets for panel mounting, pair.. 29c
A912 3 in. Dial and knob to fit..... 65c

MOULDED VARIO-COUPLER

This coupler is designed to work with the above variometer. The stator and rotor forms are of polished black moulded composition. Primary has seven taps to enable fine tuning. Wave length range 186 to 650 meters. Fitted with panel mounting bracket.

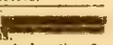
A419 Price $3.95
A910 Moulded dial to fit..... 65c

180° VARIO-COUPLER

A418 Price $2.95

Our price shows you a big saving. An instrument of highest quality. The most efficient type of coupler, insures sharper tuning and louder signals. Primary and secondary wound on genuine bakelite tubes. Secondary connections through soldered flexible cables eliminates contact noises. Primary has 7 taps. Can be panel or table mounted. Range 180 to 650 meters.

BRASS ROD



Supplied only in 12 inch lengths.

A961 Threaded 6-32, per 12 inch length. 8c
A963 Threaded 8-32, per 12 inch length. 10c
A965 Solid 3-16 inch, per 12 inch length. 10c
A967 Solid ¼ inch, per 12 inch length. 12c

TINNED COPPER WIRE

Size 14 tinned copper wire. For wiring sets. Best size for neat job and proper results

A969 Ten feet for..... 12c

CHOKE COILS AND RESISTANCES

A355 100 Millihenrie Iron core choke coil. Each $1.20
A354 10 Millihenrie Open core choke coil. Each 92c
A357 12,000 ohm Non-Inductive wire wound resistance. Each $1.58
A356 12,000 ohm Moulded resistance. Ea. 45c
A358 5 Millihenrie Open core choke coil. Each 92c
A359 1 Henrie Iron core, choke coil. Ea. $1.20

BARAWIK QUALITY HEADSETS

These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellent with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are fine polished finish with polished black ear pieces. Fabric covered head band comfortably and quickly fitted to the head. Supplied with 5-foot cord. These sets were designed to sell for much higher prices than we ask, and at our price are a wonderful bargain. We guarantee that you will be pleased with them and agree that they are the best value by far yet offered. If they don't suit you we will cheerfully return your money.

A770—2000 ohm $4.00

OTHER STANDARD BRAND HEADSETS

A751 Murdock 56, 2000 ohm..... $4.38
A752 Murdock 56, 3000 ohm..... 4.95
A764 Frost, 2000 ohm..... 4.38
A766 Frost, 3000 ohm..... 4.95
A758 Western Electric, 2200 ohm.... 9.50
A754 Baldwin Type C with universal jack plug $12.00
A755 Baldwin Type C unit with attaching cord $5.75
A788 Brandes, 2000 ohm..... $7.20

TWO-WAY ROUND PLUG

A397 Each..... $1.18

Takes two pairs of head set terminals. Quick easy connections. Polished round barrel. Fits any standard jack.

ENCLOSED DETECTOR

One of the finest crystal detectors on the market. Supersensitive galena crystal enclosed in heavy glass shield. Quick, positive adjustment. Brass parts polished nickel finish.

A730 Each $1.35

GALENA DETECTOR

Easy fine adjustment. Crystal mounted in cup. Moulded base and knob. Brass parts polished nickel finish.

A732 Each 86c

DETECTOR CRYSTALS CAREFULLY TESTED

A736 Galena, Arlington tested, per piece. 19c
A798 Silicon, Arlington tested, per piece. 19c
A735 Buzzer tested, Galena, per piece.. 12c
A737 Buzzer tested, Silicon, per piece.. 12c

DETECTOR PARTS

A725 Price set..32c

All metal parts for crystal detector. No base included. Easily assembled. Polished nickel finish.

A727 Detector Crystal Cup. Each..... 10c
A728 Cat Whisker Wire, 5 feet for..... 5c

BAKELITE DIAL AND KNOB

Moulded of genuine bakelite, polished black finish. Fluted knob. Fine engraved scale with sharp clear graduations and figures in contrasting white enamel. This is the finest quality dial and knob in a very attractive pattern. Two inch cannot be supplied for ¼ inch shaft.

A915 2 in. Diam. for 3-16 in. shaft. Ea. 40c
A902 3 in. Diam. for 3-16 in. shaft Ea. 49c
A903 3 in. Diam. for ¼ in. shaft. Each. 49c
A916 4 in. Diam for ¼ in. shaft. Each. 74c

ONE-PIECE DIAL AND KNOB

Moulded in one piece of polished black composition with clean plain engraved scale and numerals in contrasting white enamel. Ribbed knob to fit the hand. An attractive neat pattern.

A900 2½ in. Diam. for 3-16 in. shaft. Ea. 32c
A901 2¾ in. Diam. for ¼ in shaft. Ea. 32c
A904 3 in. Diam. for 3-16 in. shaft. Ea. 39c
A905 3 in. Diam. for ¼ in. shaft. Ea.. 39c
A908 4 in. Diam. for 3-16 in. shaft. Ea. 57c
A907 4 in. Diam for ¼ in shaft. Ea.... 57c

MAGNET WIRE

Insulated copper wire. Best quality even drawn wire, one piece to a spool. Prices quoted are for 8 oz. spools.

Double Cotton Covered		Enameled Insulation		Green Silk Covered	
Number A990		Number A992		Number A991	
Gauge	Price	Gauge	Price	Gauge	Price
18.....	50c	20.....	45c	20.....	$0.78
20.....	60c	22.....	55c	22.....	.90
22.....	75c	24.....	61c	24.....	1.05
24.....	85c	26.....	65c	26.....	1.18
26.....	95c	30.....	70c	30.....	1.79
28.....	$1.15	32.....	79c	32.....	2.05
30.....	1.65	36.....	98c	36.....	2.75

STRANDED ANTENNA WIRE

Cabled of fine copper strands. Very flexible. High tensile strength. Best for aerials.

A240—100' coil 65c A249—500' coil $2.95

SPAGHETTI

For covering connecting wires in sets. For size 12 and 14 wires.

A955 Finest quality braided and saturated with best baked lustrous transparent insulating varnish, 3 feet for..... 20c
A956 Best quality braid and covered with black insulating compound. 3 feet for..... 15c

RADIO JACKS AND PLUGS

Finest grade jacks. Improved design. Best materials. Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅜ in. thick.

Jacks Only
A390 Open circuit. Each..... 45c
A391 Closed circuit. Each..... 52c
A392 Two circuit. Each..... 63c
A393 Single circuit filament cont. 70c
A394 Two circuit filament cont.. 88c

A395 Plug. Large space with set screws for attaching cord. Each..... 51c

STANDARD FLAT PLUG

A398 Each..... 74c

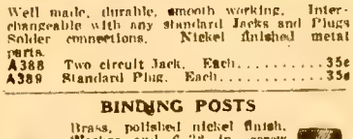
Black polished case with polished nickel insert. Fits any standard jack. Quick, solid connections.

COMPETITOR JACK AND PLUG

Well made, durable, smooth working. Interchangeable with any standard Jacks and Plugs Solder connections. Nickel finished metal parts.

A388 Two circuit Jack. Each..... 35c
A389 Standard Plug. Each..... 35c

BINDING POSTS



Brass, polished nickel finish. Washer and 6-32 in. screw extending ⅜ in.

A370 Large size—barrel and knob ¾ in. long, dozen..85c
A372 Smaller size—barrel and knob 9-16 in. long, dozen..... 70c
A374 Large size with composition knob, dozen..... 50c
A376 Large size with hole for phone tip or wire, dozen..... 80c
A378 Small size with hole for phone tip or wire, dozen 38c

SWITCH CONTACT POINTS

Brass polished nickel finish. All have ⅝ in. long size 6-32 screws. All prices the same.

Dozen 20c Hundred $1.40

Order by Article Number.

A360 Head, ¾" Diam., ¼" High
A362 Head, 3-16" Diam., ¼" High
A363 Head, 3-16" Diam., 1-16" High

Solder Lugs to Fit Contact Points

Also for connecting wires to binding posts etc.

A365 Dozen 12c—Hundred 60c

SWITCH LEVERS

Moulded composition knob. Exposed metal parts polished nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.

A382—1¾" Radius
A381—1¼" Radius
A380—1" Radius
22c Each

SWITCH LEVER STOP

Brass, polished nickel finish.

A386—Dozen 20c. Hundred $1.40

INDUCTANCE SWITCH WITH KNOB AND DIAL

Mounts switch point and contact lever behind panel. Enables you to build neat attractive set. Only one hole needed to mount on panel. 13 switch points, any number of which may be used. Dial indicates position of lever. Smooth wiping contacts. Attractive tapered knob.

A385 Price including knob and dial... $1.80

OUTDOOR LIGHTNING ARRESTER

Including Knob and Dial

A980 Price..... $1.68

Protect your instruments with this lightning arrester. You cannot afford not to. Weatherproof porcelain case. Air gap type. Permanent. Durable. The most practical quality arrester obtainable. Underwriters approved.

CABINETS

Fine looking cabinets solidly built. Made of genuine solid mahogany in elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

Panel Size	Inside Dimensions High	Wide	Deep	Art. No.	Price Each
6x 7"	5 ⅛"	6½"	7"	A420	$2.48
6x10½"	5⅛"	10 "	7"	A422	2.75
6x14"	5⅛"	13½"	7"	A424	3.30
7x14"	6⅛"	13½"	7"	A423	3.60
7x18"	6⅛"	17½"	7"	A426	3.90
7x21"	6⅛"	20½"	7"	A425	3.90
9x14"	8⅛"	13½"	10"	A428	3.70
12x14"	11⅛"	13½"	10"	A430	4.40
12x21"	11⅛"	20½"	10"	A432	5.25

SOLID GENUINE CONDENSITE CELORON PANELS

Notice our very low prices on this fine quality grade 10 genuine solid sheet Condensite Celoron (a product with mechanical, chemical and electrical properties like formica and bakelite). Machines well without chipping. Won't warp. Waterproof. Highest mechanical and dielectric strength. Attractive natural polished black finish which can be sanded and oiled for extra fine work.

Panel Size Inches	⅛" thick Art No.	Price	3-16" thick Art No.	Price	¼" thick Art No.	Price
8x7	A450	$0.50	A460	$0.75	A470	$0.98
6x10½	A451	.75	A461	1.11	A470	1.47
6x14	A452	1.05	A462	1.55	A472	2.05
7x14	A458	1.20	A468	1.80	A478	2.40
7x18	A453	1.55	A463	2.30	A473	3.10
7x21	A457	1.78	A467	2.65	A477	3.60
9x14	A454	1.60	A464	2.30	A474	3.10
12x14	A455	2.10	A465	3.10	A475	4.15
12x21	A456	3.15	A466	4.65	A476	6.20

ETCHED METAL NAME PLATES

Made of brass. Silver plated characters and border on black background. All plates are 1 inch long and ⅝ inch wide, except "INCREASE CURRENT" which are quarter circle 1⅜ inch over all, and "ON" "OFF" which are ⅝ inch long. Attaching holes pierced.

A503 Per Dozen..... 35c

Not less than one dozen assorted sold. Specify marking wanted as follows:

Plate Variometer	Secondary	Aerial
Grid Variometer	Primary	Ground
Vacuum	Tickler	Phones
Primary Condenser	Lead'g Coil	Input
Secondary Condenser	Coupling	Output
Increase Current	Parallel	On
(to right)	Series	Off
Increase Current	Detector	1st Step
(to left)	A Battery	2nd Step
	B Battery	3rd Step

(Blank—takes pencil or pen marks.)

ELECTRIC SOLDERING IRON

A957 Price..... $5.75

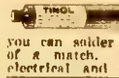
Especially adapted to radio work. Will enable you to do neat clean work quickly. Simply attach to any light socket 110-120 volts. Complete with six foot cord and attaching plug. Renewable solder point. Will last a lifetime for ordinary home or light shop work. A wonderful value at the price.

ROSIN CORE SOLDER

A958 Per Coil..... 22c

Self fluxing. Especially designed for soldering electrical connections. Fine for use with above electric iron. Coil will last a long time.

TINOL



A959 Per tube..... 19c

With this preparation you can solder your connection with the heat of a match. Works fast. Makes a perfect electrical and mechanical joint. Self fluxing.

LONG NOSE PLIERS

A970 Price.... 98c

The handiest pliers for radio work. Made of fine hardened steel. Length 5 inches.

DIAGONAL JAW NIPPERS

A972 Price..... $1.10

For fine electrical work. Made of hardened steel. Length 5 inches.

ANTENNA INSULATORS

A260 Size 1x3¼.
Two for 19c
A262 Size 2⅛x3¼.
Two for 38c
A264 Size 1½x4.
Two for 80c
A266 Size 1½x10½.
Two for $1.35

A260 A262 A264-6

SOLID BARE COPPER WIRE

Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14
A246—100' coil 45c A242—500' coil $2.85

Solid Bare Copper Wire, size 12
A244—100' coil 61c A245—500' coil $2.75

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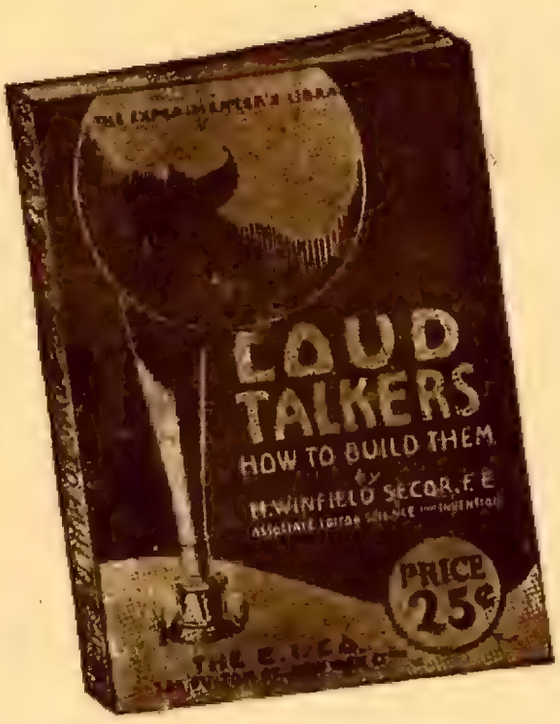


LOUD - TALKERS

HOW TO BUILD THEM

by H. WINFIELD SECOR

Associate Editor of Science & Invention

25 cents, postpaid

This book describes how to build two distinct and different types of radio loud-talkers, which can be built with either electro-magnetic field to be excited from storage battery, as well as permanent magnet field requiring no separate battery excitation. The third chapter deals with improvised loud-talkers and gives clear and complete instructions on how to build suitable horns for use with radio receivers of the Baldwin and other types. Several elaborate hook-ups are given of the author's own radio receiving set, comprising one stage of radio-frequency, detector and three stages of audio-frequency amplification, together with all the connections for the loud-talker.

Complete data is given for all the parts of the loud-talkers, including the field magnet windings, as well as the diaphragm or moving coil windings, and also the step-down transformer to be connected between the vacuum tube amplifier and the loud-talker proper.

In preparing these designs the point has been constantly kept in mind to use the simplest parts possible, so that practically anyone can build a successful loud-talker equivalent to the commercial types costing $40.00 or more.

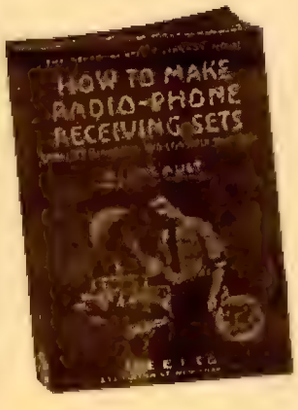
Even where the experimenter does not possess the skill or the time to make all the parts himself, which are really few in number, he may save a great deal of money, or at least half the price of a commercial loud-talker, by having the difficult parts made in a local machine shop, and then assembling them and winding the coils himself. Circuit connections and data for the size of wire, etc., are given for placing the loud-talker on a separate floor or in another part of the house not occupied by the radio receiving set. A very valuable book, giving data which cannot be obtained anywhere else and which has not been published before.

64 pages, 25 illustrations, bound in beautiful two-color cover, size 5½ x 7½ inches; Price prepaid, 25 cents

Have You a Copy of These Two Books?

HOW TO MAKE RADIO-PHONE RECEIVING SETS 25¢

By ROBERT E. LACAULT
Associate Editor RADIO NEWS



A non-technical book for the beginner. Gives complete constructional data on the building of a complete Crystal Detector Set, Tuning Coil, Loose Coupler and a Single Audion Tube Set with Amplifying Units. It furnishes all dimensions and working drawings of every part that must be constructed by the amateur. Written in plain, simple language that anyone can understand. The opening chapter gives a complete description of the theory of radio and tells what it's all about, teaching the principles of wireless so that the constructor knows what he is doing.

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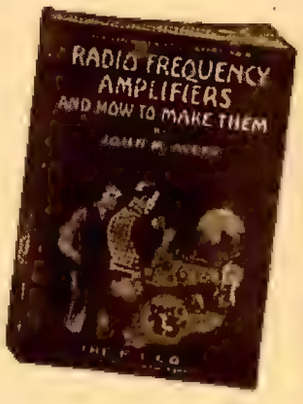
By JOHN M. AVERY

This book is for the more advanced amateur, showing the construction of the Radio Frequency Amplifying Transformer and giving complete constructional data. It shows the application of Radio Frequency to amplifying units that the amateur may already possess and gives 15 hook-ups showing practically every use Radio Frequency Amplifying Transformers can be put to.



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THE E. I. COMPANY 233 FULTON STREET NEW YORK CITY, N. Y.

Dr. Hackensaw's Secrets

By CLEMENT FEZANDIÉ

(*Continued from page* 900)

"There is no noise, no smoke, no jerking, no smell of gasoline. Off you go in your auto or airplane, and if you want a meal on the road, your radium will cook it for you. It will keep you warm in winter and cool in summer. It will furnish light for your car and run an electric fan to keep flies and mosquitoes away. You can even have an ice box in your car, for the radium will evaporate ammonia and enable you to manufacture ice. I have also invented means for inserting small amounts of radium in the weaving of cloth, so that your clothing will keep you warm in winter or cool in summer, the temperature being under perfect control. But why continue the items of this enumeration—there is practically no limit to the uses to which radium may be put. It is also fool-proof, for the container is strong and cannot be opened unless you smash it open on purpose. A very simple mechanism prevents the emanations from escaping except when the can of radium is placed in the proper position in the machine which it is desired to run. A lever turns on or shuts off the emanations at will. I am already arranging for public automobiles—or rather radiobiles as I shall call them—stationed in every street. All of my subscribers will be furnished with a six gram can of radium. Whenever they wish to ride they have merely to pop this into the first auto they find and ride to their destination.

"My radium, as I told you, may also be used for lighting purposes either by transforming the energy into electricity by means of a dynamo, or by using it for the softer forms of glow-light, less trying to the eyes. But here I am keeping you up to all hours of the night, and you must be tired. I'll give you further explanations some other time. Only, let me tell you one thing. That metal door in front of you leads to a radium-proof room in which there is so much radium, ready for the market, that, at present prices, all the gold in the world would not be sufficient to buy it!"

* * * *

"Whew!" whispered Dago Jake to his companion. "That was an awful long-winded yarn, wasn't it. But I'm glad to know the radium is worth more than gold. It's easier to carry, too. Here's the metal door the doctor spoke of—this one marked 'Keep Out! Danger!' Great snakes! The door isn't even locked! This is luck and no mistake!"

A moment later the two rogues were in the radium-proof chamber and surveying a pile of closed boxes of different sizes.

"This is the stuff!" cried Dago Jake, seizing one of the largest boxes, labelled "Radium—Three Pounds."

"You can have it," said Shrimp, contemptuously. "Me for the gold!"

"All right, but these three pounds of radium are worth more than all the gold you could carry."

"Is that so? Let's see the blamed stuff!"

"I can't. The darned box doesn't open."

"I'll open it!" cried Shrimp, and seizing a fire-axe from the wall, with a few lusty blows he succeeded in breaking open the case in which the pure metal was contained. Then he gave a cry,—but only one,—and he and his companion fell senseless on the floor.

Doctor Hackensaw was saying good-bye to Silas Rockett, when he was startled by the violent ringing of his radium alarm—an ingenious device he had installed to give him warning when any particles of radium happened to get loose on the premises. With

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Building, general construction and engineering lines are booming. Not enough technical experts are to be had to fill the important jobs. Big pay and big opportunities are ready for men with specialized training. Chicago "Tech" gives this training to ambitious men—*by mail* to those who cannot come to the College. Read below how two Chicago "Tech" men have succeeded. Hundreds of others report similar successes. Your chances will be as good as theirs if you do as they did—*get the training* that will make your services worth a high salary. Just a few hours a week under the direction of the Chicago "Tech" experts and you can become an expert yourself. Make your spare time count for advancement.

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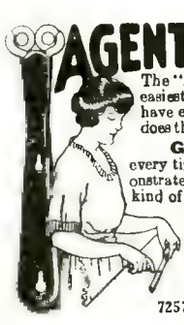

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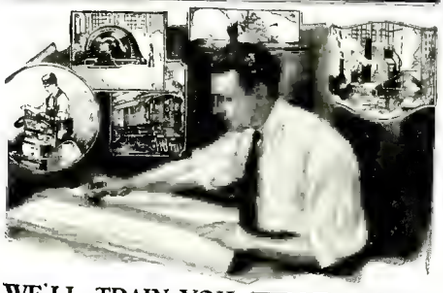

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The Paradise Railway

(*Continued from page 842*)

the greatest haste, the doctor donned a radium-proof suit, and giving another to Silas, he rushed back to the store-room to see what was the matter.

He pushed open the metal door to the radium chamber, and a single glance told him the whole story. The two charred bodies were beyond any earthly help, so the doctor turned his attention to the loose radium. With Silas's help he had soon imprisoned it in a new container, and then, by means of a special vacuum suction apparatus, he removed the radium emanations from the air, and the machine had soon condensed them into metallic form again.

By the time this was effected, all that remained of the two thieves was a small heap of calcined bones!

way that the gentleman was undesired and he must therefore continue the ride, humiliated by his sudden estrangement.

The ride leads from there to another structure of a similar nature, where the same effect can take place, and thence down to the exit. During the journey, the tracks cross and recross themselves many times. Elaborate safety devices as well as block signals, are installed to notify the operator that the progress is smooth and even. At any time along the route he can stall the cars by setting signals against them, and applying the necessary brakes from his unobserved operating station. The car coming to a crossing first, automatically stops any other car, until the first named car has cleared the junction of the tracks and should there be a series of cars, one in back of the other awaiting their chance at such intersections, they follow each other in regular order without colliding. The switches in the "paradise apple" domes are also operated by the master controlling device, and any of the cars can be shunted to a side-track retarded or removed from the run entirely at any time.

A third track will probably be added to this railway which will be known as the single ride track. A couple traverse the entire route of the railway on this track without going through the introducing ordeal. Individuals averse to making chance acquaintances, will find this last named journey very gratifying, inasmuch as they can practically act as overseers or observers of frivolities taking place elsewhere along the route.

The apparatus shown in our diagram and the photos which accompany it, are products of German ingenuity, the electro mechanical railway being co-invented by Baroness Olga von Tautphoeus, and her husband, Egon Freiherr von Tautphoeus. The American version of it is being taken care of by Adalbert Daschner, long associate with the Tautphoeus' amusement plan. No pilot is required to operate the individual cars, the occupants doing all the necessary work; they have the assistance of only one master operator. Lamp signals notify him of the wishes of any of the occupants on the two individual tracks. He but does their bidding, pressing buttons to control the varying operations. Either occupant may actuate the controlling buttons on his or her car reporting in this way to the master operator. Of course collisions of the cars are prevented automatically.

The public can view the various proceedings from observation platforms, and even comment upon the possibility of the rides being continued side by side with the chosen companion, or whether or not one or the other of the riders is going to decide to separate from his companion in the discreetly concealed paradise apple rotundas.

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Build Your Own Reflecting Telescope

By C. E. BARNS

(Continued from page 872)

In constructing the mounting, three things are essential: rigidity, ease and smoothness of the working parts, and balance. It may be set up in any open space, or on a flat house-top—anywhere commanding a comparatively unobstructed view of the heavens. A dome or even a housing is not entirely essential since by fitting a tight, felt-lined cap over the speculum (reached through a door in the side of the telescope tube), and enclosing the open end of the barrel with a canvas bag, and tying a piece of tarpaulin over the entire working parts, it will stand the year-round weather. A well-silvered mirror is good for a year or more, though it is a simple matter (and an always pleasant experiment) to take it out of the barrel and resilver it if it shows deterioration; and the chemicals work even better with months of standing in a dark place in rubber-stoppered bottles.

Choose then a spot that has at least a free north-and-south view, setting solidly in the ground a four-by-four post two feet below and two feet above your platform. Around this set a box made of twelve-inch boards, placed squarely to the points of the compass, fill the spaces between post and interior sides of the box with crushed stone and concrete for solidity, placing thereon a heavy hardwood platform, squared and leveled.

The ordinary alt-azimuth mounting is easiest of construction, but the equatorial gives the greater satisfaction. Ordinary inch and a half and two-inch iron piping can be used to advantage so long as the joints are machine-threaded for accuracy, not hand-threaded. The bearings on both polar and declination axes may be ordinary tight-fitting steel collars, but any second-hand automobile shop can supply ball-bearing supports from discarded motor cars for a dollar or two each, and these will give your telescope perfect ease and smoothness of motion in following a star or planet. Right ascension and declination circles can also be constructed of discarded belt-wheels, painted black and marked off in white, the former with Hours and Minutes, I to XXIV, and the latter Degrees and Minutes, 1° to 180°, running each way, the reading depending upon which side of the pier your telescope is swung. Old clock-hands affixed to the iron tubing will do for indicators. When the declination axis is perfectly horizontal, the R. A. circle should be set at 0 hrs., min., and secs. When the telescope points directly to the North Star (Polaris), the declination circle should be set at 90°.

A heavy wedge of wood supports your telescope, and this should be sawed to an angle equal to the latitude of the place, so that when the polar axis is set upon it, on looking through it, Polaris should be accurately centered. Get your north-and-south line as accurately as possible, although the determination of the true meridian is a task which tries the souls of some of the best astronomers. A fair approximation only is essential.

The metal telescope tube is probably one of the things that had best be left to the trained metal-worker; and for a thorough piece of work should not cost more than seven or eight dollars. It should be eleven inches in diameter throughout—an inch larger than the mirror; and four inches longer than your focal length—ninety-four inches to end of sleeve in case you have ground your ten-inch speculum at the ratio nine to one. A door should be cut in the lower end, properly placed and large enough to pass the mirror in and out without ever

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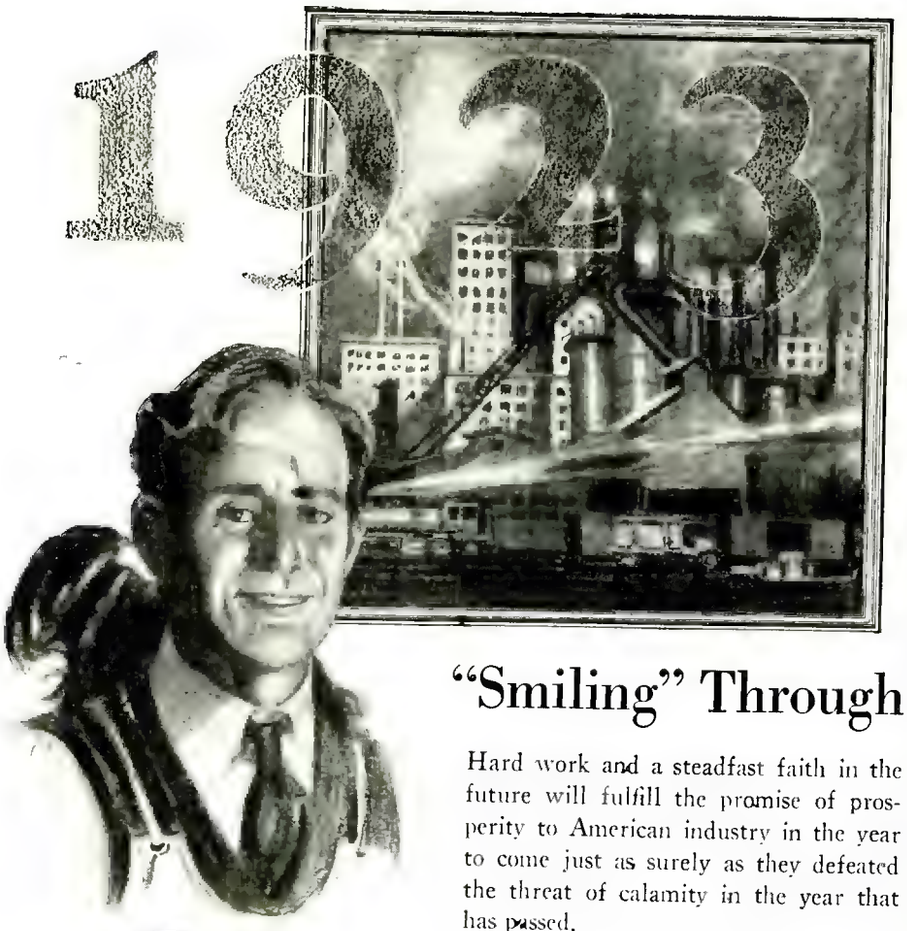

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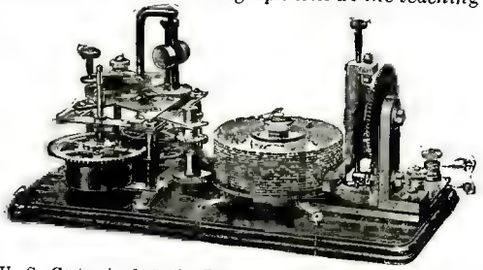

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touching its face; and the upper end should be fitted with a revolving sleeve extending eight inches or more over the main barrel. This sleeve carries your finder, diagonal and eyepiece, and can be fitted with rings to run smoothly. In smaller reflectors the entire barrel revolves in its bed; but with a ten-inch the revolving sleeve is far better, as the finder and ocular can be instantly adjusted for seeing, in whatsoever position the telescope stands. In the side of the sleeve a hole is cut in which is fitted a block to hold the ocular-tube which should slide in and out easily to get a proper focus. With a steel tape and the sun's image thrown upon a piece of cardboard, determine as accurately as possible the focal length of your mirror, then cut down or lengthen your telescope tube to correspond. Remember, this focal length represents the distance between mirror and eyepiece, not alone from mirror to diagonal.

The diagonal, or Newtonian flat, as it is called, is merely an oval piece of glass, silvered on the face like the speculum, and set at right angles in the focal plane opposite the eyepiece. The diagonal may be cut out of any piece of plate glass, free from scratches, ground oval and large enough to receive the reflection—say, one and one-half by two and one-half inches, and silvered in a small agateware dish as carefully and polished as brilliantly as the speculum itself. This may be clamped (not merely cemented), to a block of wood cut accurately to forty-five degrees and supported in the focal plane opposite the eyepiece by a series of wires running crosswise through the barrel. I have found a right-angled prism of optical glass preferable to the Newtonian flat, particularly for celestial photography as it reflects 100 per cent., but they are usually made to order and cost twelve dollars. All the large reflectors use plane mirrors for diagonals; and if the silvering and polishing is well done, the loss of light by reflection is negligible for visual work.

It is scarcely necessary to state that your instrument will need counterweighting to a point where all movable parts work smoothly. I have found old stereotype metal, to be purchased for five or six cents a pound at almost any print-shop, the best for counterweights as it can be melted and poured into a small space, and is very compact and heavy.

As for eyepieces, I have a complete battery of them; but I must confess that an ocular of my own construction, made of lenses that once did service, I fancy, in some little old tintype gallery, ground by a famous English lens-maker of long ago, is my favorite for observational work. I think I paid a dollar for six of these lenses in a second-hand shop; and though the rest of my oculars cost from four to thirty-eight dollars each, I get the best service out of these castaways which give me from about sixty to one hundred and ten diameters. You never know when some battered and antiquated cell in a cobwebbed window contains a mighty fine lens that is just what is needed for an eyepiece; and even if the amateur does secure his oculars from some reputable dealer and pay the price, he will nevertheless continue treasure-hunting along these lines.

And what is true of eyepieces is also true of finders; for one may often pick up a small but powerful field-glass, giving a clear wide field, in which he can insert cross-wires, that may be mounted on his reflector and serve his purpose as well as one of the professional kind that costs twenty to forty dollars. A finder is a great help, and in some classes of work quite indispensable.

Let me say in conclusion that one of the best travelers I ever met was a man who was never in a hurry to get to his journey's end, but took all the pleasure and profit out of the day's progress that he possibly

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Submerged Spotlights for Niagara

(*Continued from page* 843)

least a partial, reflection of light, as is often done experimentally in the physics laboratory. For water, this critical angle is 48 degrees, 27 minutes, and 40 seconds, but such great accuracy with powerful beams of light would not be necessary, as at no time does the water develop a smooth jet. Consequently the internal reflection in this stream of water would not be regular, but intermittent, the beams of light being irregularly reflected from fine particles of matter suspended in the water. The sunken spotlights have an automatic cut-out device in them, which will release the spotlight sinking arrangement and expel the water ballast if, when current to the lamps is turned on, the bulb fails to light, either because it has become broken or burnt out.

The chamber thus becomes a buoy, rising to the surface, where by means of a cabled tramway it may be grappled for, raised, repaired, and again sunk into its previous position. This cable tramway, large enough to contain a few operators, would be out of sight unless repairs were necessary, which repairs could be conducted in the early hours of the morning, when but few people are viewing Niagara's splendors; spotlights and shore searchlights assisting the electricians in this work. It is evident that a certain depth of detail will be obtained with this lighting arrangement, which cannot be accomplished with flood lighting methods.

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How to Use Your Camera

By DR. ERNEST BADE

(*Continued from page* 874)

camera itself is the finder and gives, at the same time, an image of the object the size of the plate. This can easily be focused. But the separate view finders, while good enough to bring large objects upon the plate, cannot be used for focusing. This is only possible upon the ground glass, and even then it often becomes a necessity to use a hand lens to get the details. For still finer work the ground glass is entirely unsuited. Then it becomes advisable to place a drop of Canada balsam upon the center of the uneven surface of the glass, and to place upon this a thin, microscopic cover glass. This will make the center as transparent as the original glass and through this clear glass the object can be focused most sharply with the aid of a hand lens. Only with the aid of such "tricks" is it possible to correctly focus microscopic and microphotographic work.

When smaller objects, as for instance flowers, are to be taken in their natural size the bellows with which the smaller cameras are provided are too short. But this can easily be overcome by providing a tube of wood or cardboard, one end of which carries the lens while the other is attached to the camera. The entire device must be light-tight. This extension should not be shorter than eight inches and must be painted a dull black on the inside. The time of exposure must be increased, as the light passing through the lens to the plate decreases with an increase of the length of the bellows and extension.

If the photographic lens is screwed directly to the camera, a metal tube must be procured which can be firmly attached to the camera. The other end of the tube then carries the lens. Such a metal tube must be threaded at both ends.

Since the camera should be immovable, it is to be fastened to a stand or tripod. This should not be weak. One made of metal tubes is suitable for small cameras but not for larger ones. Then, too, it is often necessary to photograph objects which may be considerably higher or lower than the tripod, or which must be taken at an angle. Here the tripod alone can seldom be of service. Therefore it is advisable to have an attachment which will permit the camera to be tilted either upward or downward, as required

Such an attachment can easily be made. It consists of two boards approximately the size of the camera. The narrower ends are hinged at one end. The upper board, which is to carry the camera, is provided with a winged bolt; to the lower board a nut is attached so that it can be fastened to the tripod. Then the other upper end is provided with a winged nut and bolt, the lower end carries a round headed screw to which a stiff wire is loosely fastened, the wire being bent double. This runs upward to the winged nut. By this means, after the lower board is fastened to the tripod, the upper board carrying the camera, can be raised or lowered to any convenient angle and fastened firmly in position by means of the winged nut, the tripod being in normal position resting solidly on the ground.

BORON AS A STEEL ALLOY

Experimental work performed by the United States Bureau of Mines indicates that the use of boron as an alloy confers marked hardness on steel. If the other physical properties of the boron steels are good enough to be applicable to commercial use their remarkable plasticity at temperatures below the melting points of ordinary steels might make it possible to utilize this characteristic.

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Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

NOTE:—Before mailing your letter to this department, see to it that your name and address are upon the letter and envelope as well. Many letters are returned to us because either the name of the inquirer or his address is incorrectly given.

Talking Pictures

(676) Michael S. Arapis, New York City, asks: "How does the Kellum talking picture machine take care of breaks in the film? I have a film which is absolutely unbreakable. Is it worth anything? Its cost is not much higher than regular movie films." He also raises several questions concerning synchronization in the former pictures.

A. To a certain extent you are wrong in your ideas concerning the Kellum film synchronizing methods. If they used two phonographs, one of the phonographs is equipped with an automatic trip. This starts the other phonograph going, and the voices on both records overlap. So perfectly is the voice on the two records synchronized, that when both phonographs are going, you would not know the difference except by an increase in volume of sound. Therefore, a damper is employed which cuts down the sound of one phonograph, increasing gradually the sound of the other, until eventually the second phonograph is operating and the first one not at all. In case a large break occurs in the film, blank film is inserted if a duplicate repairing film cannot be obtained. These blank spaces are distributed over a space of several feet, bringing the ultimate length of the film back to what it should be. The only effect such insertion has is a slight flickering, normally not found in the film, but evident when numbers of these blank spaces have been inserted.

If as you state, your film is absolutely non-breakable, you may have a valuable product as there is much annoyance caused by breaking films, and their fragility brings about deterioration.

Auto Lock

(677) Roy Cusick, Coatesville, Pa., requests our opinion on an auto lock placed in the gas line or somewhere along the intake pipe.

A. Referring to your lock for automobiles, we would advise that locks inserted into the gasoline supply leads, either between the carburetor itself, or in the intake manifold, are not new, most of these ideas being covered by patents. Merely employing a combination lock in place of the key lock, does not give you a very satisfactory claim for a patent, particularly in view of the fact that your combination lock possesses no radically new features, nor does it depart from such locks now found upon the market. The disadvantage of the lock you have designed is in the fact that the engine hood must be lifted every time you wish to lock the engine. We do not advise applying for a patent on this suggestion. They can also be "jumped" easily by cutting the pipe on each side of the lock and connecting the two pipes with a piece of rubber tubing.

Our Endeavor

(678) H. L. Clary, Milwaukee, Wis., asks whether the advice we give is personal and for his own benefit.

A. The service which we give is absolutely personal; we making it a rule not to divulge the inventor's idea whether good or bad. Unpaid letters are answered in this column, but when a fee is enclosed to cover charges of mailing, etc., the answer is not published on this page unless desired. You can feel free to communicate with us regarding your devices, and we can assure you of an unbiased opinion, absolutely personal, if you so desire, intended for your own interests.

You must be prepared, however, to receive information which will not always be to your liking, but our experience in handling thousands of cases, enables us to judge more readily than the inventor himself, the value of a device, and the chances it stands in being placed before the public. Therefore, if your device possesses no merit, we do not "beat about a bush" in giving you our opinion. We do not lay any claims to infallibility, however, and if you believe that in your own opinion you can make a success of the device and are willing to take a ten to one gambler's chance with odds against you, we are glad to make suggestions. Remember it is our opinion which you request, and we give it, not caring whether John Doe is in favor of it or not. We are always ready to correct mistakes, however, but our statements are carefully weighed and considered before given.

Direction Indicator

(679) G. W. Carpenter, Horton, Kan., submits a sketch of an automobile direction indicator, in the form of an illuminated arrow. The direction to which it points indicates the course the machine is to take. It is controlled by the steering wheel.

A. We do not think very highly of your idea of an electric indicator, to show the direction the automobile is to take. As a matter of fact, we would not advise a patent on any direction indicator for automobile use, for unless you can place the devices on the market yourself, financing all the work, you stand no reasonable chance of selling anything but an exceptionally clever invention.

Level and Inclinometer

(680) R. J. Cooper, Watertown, N. Y., enters a sketch of a water level having a square hole holding the water or spirits, the object being to read the inclination of the surface in degrees.

A. Your water level made in a square tube has practically no value, because of the fact that the globule of air in the top of the level will always tend to displace itself, as the sides of the containing vessel are entirely too large. Remember also, that the globule of air always becomes a spheroid or oval. Consequently, very accurate readings are thus unobtainable with your device. By changing the shape of the tube or making the tube of the level larger, its efficiency is destroyed immediately. A weight hung from a sector, which sector is equipped with a level, makes a much more accurate level or inclinometer than your water device. If your intended purpose was to build an inclinometer, then we would state that the device will be far from accurate, because of the capillary action of the liquid, and the peculiar concavity of its surface in these tubes. We do not believe that such a device if patented, and placed upon the market, would meet with even slight favor.

Protecting an Idea

(681) H. E. Berry, Providence, R. I., asks how he can protect his idea while prosecuting a patent and having the model built.

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Winners of Loud-Talker Contest

(*Continued from page 879*)

described below, utilizes the sound box and the horn of a "hill and dale" type phonograph.

The field coils with cores of this loud-talker are two electro-magnets removed from an old telegraph sounder and mounted upon a base as shown. The upper end of each core is drilled and tapped to a depth of about ½ of an inch and a short strip of soft iron is bolted to each. Each strip should be about 3/16 of an inch thick, and as wide as the pole pieces of the magnets. They should be of such length that their ends will be 3/16 of an inch apart, as shown in the accompanying diagram.

On each side of the electro-magnets, drill a hole in the base, through which long machine screws are inserted. A nut should be run down on each one to clamp it to the base. Next obtain a strip of thin, first quality mica, about ¾ of an inch wide, and slightly longer than the distance between the two machine screws. Drill holes in each end of this strip, so that it may be placed upon the two screws. In the center of the strip, directly over the center of the space between the two pole pieces, drill another hole. A circular diaphragm placed in the same way could also be used.

We will now proceed to the winding of the movable coil. Make a form or template of two wooden blocks as shown in Fig. 3, with a core ¼ of an inch in diameter. The two side plates of the template should be carefully placed, so that their inner surfaces will be perfectly parallel and ⅛ of an inch apart. They should also be arranged so as to be readily removable, after the coil is wound. On this template just constructed, wind about 500 feet of No. 44 enameled wire.

After the required number of feet are wound on the coil, one side of the form should be carefully removed, and thin shellac applied to the exposed side of the coil. After this dries, remove the core and the other side of the form, and carefully shellac the other side of the coil. After the shellac dries, wind very carefully several turns of fine sewing silk around the coil, taking care to preserve its shape and thickness.

Now obtain a split copper rivet, and insert it in the center hole in the mica strip. Fasten this firmly in place with shellac. Place the moving coil between the two legs of the rivet, and squeeze them lightly together, taking care not to damage the coil in so doing.

Now assemble the component parts as shown in Fig. 1, and over the entire apparatus place a box, in the top of which is a large hole to admit the needle on the phonograph reproducer.

The instrument is connected without the use of a step-down transformer, as shown in Fig. 5, and is placed upon the top of the phonograph, as shown in Fig. 2. The result will be, if properly constructed, a loud-talker whose operation will be equal to the best on the market.

(*Continued on page 920*)

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Answers to Puzzles

(*Continued from page 867*)

AROUND THE WORLD IN TWENTY-FOUR HOURS

To individuals in a balloon the earth does not seem to turn at all. Unless the balloon is borne by air currents it remains suspended above the same spot indefinitely. This is because the atmosphere rotates with the earth, and at the same rate.

If the atmosphere did not share in the general rotation of the earth and all objects on it, our lives would not be safe for a moment. A tremendous gale, which near the equator would have a velocity of about a thousand miles an hour, would sweep westward around the world, overturning houses, uprooting trees, and bearing people as well as all loose objects with it in its course. Even if there were no atmosphere to produce the gale our experiences would indeed be extraordinary if our bodies had no tendency to rotate with the earth every twenty-four hours. During the short interval involved in jumping upward five or six feet the earth would rotate far enough to land a person half a mile or so from the spot from which he leaped.

Because of its greater mass the lead ball would be retarded less by the force of friction than the lighter iron ball. Consequently the lead ball would fall a little faster than any lighter object presenting the same surface to the air.

STARS THAT APPEAR TO MOVE EASTWARD

Owing to the rotation of the earth on its axis most stars appear to rise in the east, move westward in the sky, and set in the west. At the poles, however, the stars would appear to move in concentric circles about a point directly overhead. Even in temperate latitudes some stars never rise or set but move in circles counter-clockwise around the pole star. Thus to people in the latitude of New York the stars of the dipper never rise or set but appear to move westward above the North Star and eastward below it.

CROSS-EXAMINING A WITNESS

At midnight the sun is on the other side of the earth from us. If the moon at that time were high in the sky and the meridian, it is obvious that the phase of the moon would be *full* instead of *quarter* as described by the witness. A quarter moon at midnight would be near the horizon. Either the witness was mistaken in regard to his observations or else he was not abroad on the night about which he is testifying. We are inclined to think that if anything was full on this particular night it was not the moon.

PARLOR MAGIC

If one remembers that the pressure of a gas against any surface is produced by innumerable blows of tiny air particles that in their random motions happen to strike the surface, the explanation of the results of this experiment will not seem perplexing. Thus in the accompanying diagram the pressure of the air against the piece of paper while represented by arrows at A is really maintained by millions of tiny particles striking the surface per second. By their impacts they maintain a pressure of about 14.7 lbs. per square inch against the surface of the piece of paper. Ordinarily there are an equal number of particles striking the surface from the other side and so there is equal pressure on both inner and outer surfaces of the piece of paper. Now as soon as one begins to blow through the spool one would naturally think that the pressure against the piece of paper would be more

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than 14.7 lbs. per square inch and so the paper should fly off at once. But what really happens is this: As the air particles escape from under the edge of the paper they move parallel to the surface of the piece of paper. Consequently fewer of the articles strike the paper perpendicularly, and less than normal atmospheric pressure results. The atmospheric pressure against the outer surface of the paper now exceeds the air pressure against the inner surface and so the paper is maintained in position.

MORE PARLOR MAGIC

The explanation of the results of this experiment are similar to the one given above. Blowing through the space between the books results in a reduction of pressure on the under surface. Air pressure on the upper surface then pushes the paper downward between the books.

Remarkable Tornado Photos

(*Continued from page* 862)

At this point the path was 50 yards wide. Continuing in a southerly direction, the wind next struck at St. Edward's College, where the dormitory, gymnasium, and power plant were destroyed. Men working at Penn Field who were watching the approach of the storm said, "It looked like a funnel-shaped mass of cloud and dust, churning and whirling and carrying things high into the air and then scattering them in all directions." At the center of this whirling mass was a small black core about as big around as a man's body (viewed from Penn Field about one-half mile distant), moving along in a zig-zag path, swinging very much like the trunk of an elephant. As this black core moved forward everything seemed to rush in to meet it. Large trees were torn up by their roots and drawn in, tops first; buildings of all sizes just seemed to go to pieces, and the materials, especially the roofs, sailed in toward this central core, where they were torn to pieces and carried high into the air. Some of this material was thrown out at a height of 100 feet or more, while some of it disappeared entirely.

While the *eastern tornado* was by far the larger and more destructive, it was not seen by nearly so many people as was the *western one*. It was this spectacular western funnel which practically everyone was watching while the eastern funnel formed and cut its destructive path through the southwestern portion of the county. The wind from this cloud was first felt in contact with the ground at a point about six miles northwest of this town, where some farm buildings were damaged. Its next important destruction was about three miles farther south, at the State School for the Negro Deaf, Dumb and Blind. At this institution the industrial building, the laundry building, and a dormitory were destroyed. Moving in a southwestern direction and along a line practically parallel to the path of the eastern cloud, it next struck at Deep Eddy on the river's bank. At this point considerable property damage was done and two persons injured. Lifting a large volume of spray high into the air as it went, the whirl crossed the river, cut a path about 25 yards wide through the timbered hills, and eventually disappeared to the southwest. The path of this funnel while in contact with the ground was about three miles to the west of, and practically parallel to, the eastern funnel.

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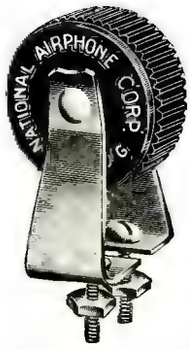

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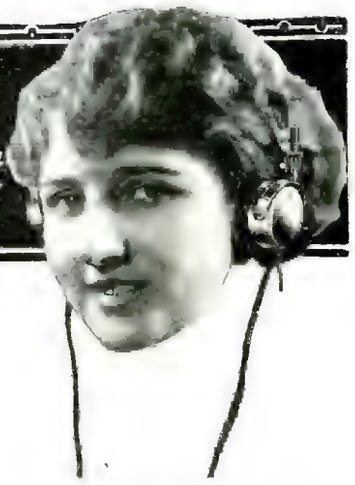

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Movies That Talk

(*Continued from page* 898)

producing organism. This he found in the electrostatic telephone. This consists of a thin tight foil of aluminum, stretched around its edge like a head of a drum (See Fig. 3).

The solid portion is a brass casting with numerous holes or grooves or the equivalent. The upper surface of this casting is flowed over with a thin layer of lacquer. Instead of lacquer, thin isinglass or tissue paper can be used. The potential difference of the electrostatic telephone lies btween 300 and 700 volts. The holes in the brass casting serve for the following purpose: Between the aluminum foil 0.01 mm. thick and the brass casting or frame, there exists next to the insulating layer an exceedingly slight air cushion which must be compressed. Seibt found that the compression of this layer of air was very high. The holes or grooves served the purpose of giving the air a chance to escape. It must not be forgotten that the electrostatic telephone is very favorable in the direction of perfect reproduction of speech, yet is by no means absolutely necessary for the production of the talking film. A great disadvantage of the electrostatic telephone is the always high potential. Seibt has recently succeeded in replacing it by an electro-magnetic telephone, which for wireless telephony is very extensively used.

The hook-ups for the speaking film, according to G. Seibt, are given in Fig. 4. Above is the receiving apparatus, and below the transmitting apparatus; *a* is a condenser microphone, which by the transformer, *b*, is connected to the high-frequency amplifier, *c*. By a second transformer, *d*, this is coupled to the two electrodes of the nitrogen tube, *e*, with its capillary connection; *f* is a battery, *g* are choke coils, *h* ohmic resistance, *i* is a condenser. The rectilinear or thread-like image of the capillary tube is projected by the lens, *k*, and the slot, *l*, on the movable film, *m*. It must be observed that in the diagram the nitrogen tube, *e*, is shown turned through 90° only to make the illustration clearer. The image is developed, fixed and dried.

For speech reproduction the arrangement shown in Fig. 4 is adopted. As a source of light a Nernst lamp or some similar one is used, which throws a fine wedge-shaped streak of light through the lens, *o*, and the slot, *p*, upon the film, *q*, moved in front of it. According to the intensity of the image more or less light falls on the photo-electric cell, *r*, whose cathode by a battery, *s*, is connected to a high-frequency amplifier, *t*, as is also the anode. To the outlet tube of the high-frequency transformer, a condenser telephone is connected to convert the electricity back into sound.

With an arrangement similar in principle to this, Lee de Forest has made images of speaking films of which some are reproduced in actual size on page 847, in order to show their appearance. From this representation, one can see how the position of the mouth accords with the photographed undulations next to the picture.

It is not by mere chance that the development of talking films is almost exclusively taken up by wireless experts like G. Seibt, Lee de Forest, S. Loewe, for the methods of wireless technique as regards the close relationship to the problems to be solved, find application inevitably in the speaking film. In the beginning, according to all witnesses, speaking films were brought out first by G. Seibt.

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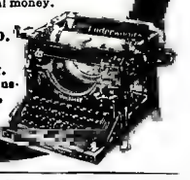

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AN ELECTRO-PHOTOGRAPHIC TALKING MACHINE

By Dr. Alfred Gradenwitz

It was my good fortune some days ago to inspect a remarkable outfit achieving a result attempted since the early stages of cinematography, viz., registering on a film, side by side with the picture, a true record of the accompanying dialogue. Inasmuch as this outfit comprises a number of novel apparatus devoid of any mechanical organ of transmission, each of which in itself is a marvel of ingenuity and doubtless lends itself to other applications as well, a short description of them will possibly interest our readers.

(a) *The Electric Ear.* The first organ designed by the inventors, Messrs. Hans. Vogt, Dr. Jo Engl and Joseph Massolle, can be fitly termed an *electric ear,* and is a microphone comprising no magnets or mechanically vibrating parts and thus instantaneously responding to the slightest whisper. Scientifically it is known as the *cathodophone,* and may be briefly described as follows: The sheet metal funnel visible in our figure is relied upon to collect the sound waves, concentrating them on a nozzle behind which is provided a wire raised to a white heat by the passage of an electric current, and giving off electric particles or electrons, thus ionizing the air around it, *i. e.*, making it a conductor of electricity. If, accordingly, an electric tension be applied between the incandescent wire and the nozzle above referred to, secondary electric discharges will take place in the interval. Now, the effect produced by talking into the funnel will be to alter the ionization in and, accordingly, the conductivity of, the air surrounding the incandescent wire, accurately at the rhythm of sound waves, thus resulting in fluctuations of the current traversing the second circuit. Inasmuch, however, as these fluctuations are incredibly small, of the order of about one-millionth ampere, an *amplifier* similar to those used in wireless telegraphy, but specially constructed for the present purpose, had to be inserted. This will reinforce the original fluctuations with absolute uniformity, thus avoiding any deformation.

(b) *The Ultra-Frequency Lamp.* The next piece of apparatus to be described here is a lamp based on the vacuum tube principle and fed by the fluctuations of electricity reinforced by the amplifier. The light given out from this lamp, of course, fluctuates at the same rhythm and responds uniformly to all vibrations within 16 and 10,000, leaving a photographic record on a narrow strip to the left of the picture section of the film.

(c) *The Electric Eye.* In order to reproduce the sound thus photographically recorded, the light from a steadily burning lamp is allowed to pass through a narrow slit and the film is evenly unwound by means of a special arrangement in front of it. It thus strikes what is termed an *electric eye,* viz., a photo-electric cell responding without any lag or inertia to the most rapid fluctuations of light, and setting up corresponding fluctuations of electricity. It is a glass bulb traversed by an electric current and coated inside with a chemical (potassium, rhubidium, etc.) layer which, on the impact of light, will give off electric particles, electrons, thus increasing the conductivity of the electric eye and raising the intensity of the electric current passing through it. These fluctuations of electricity are of the same minute quantity as those used to record the sound, and, accordingly, must be reinforced by some type of amplifier tube.

(d) *The Electric Mouth.* This is a loud-speaking telephone devoid of any magnet and based on a decidedly new principle, viz., the variable electro-static attraction between two disks placed in front of one another.

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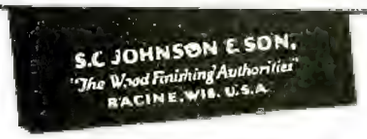

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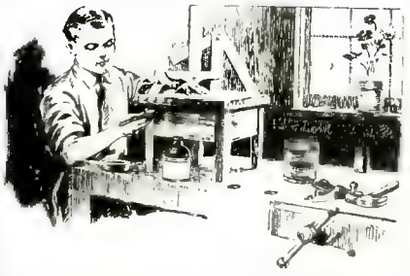

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Stereoscopic Motion Pictures

(*Continued from page 857*)

were being viewed from first the right eye and then the left. The speed of projection would probably be increased in this motion-picture machine, so that the scene will not appear jerky. Due to the peculiar properties of the human eye, with regard to retaining images impressed upon its retina, the stereoscopic effect is obtained. Of course the position of the images on the screen are jerked to the right and left rapidly, but due to the high speed at which they are projected, only one image is seen, which, according to the inventor, appears to possess those physical signs of relief which engineers are now trying so hard to obtain.

Naturally, whether this device proves successful remains to be seen after the experimental model has been given a thorough test.

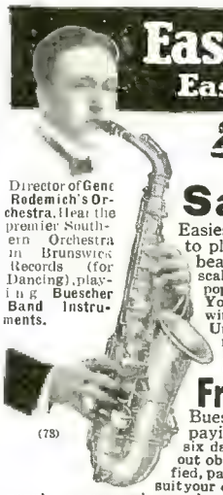
Another of these developments is one invented by Frederick Lehnhoff Wyld, a Parisian. His method of obtaining stereoscopic effects is different from the methods described in this article. In this device an ordinary motion-picture film is employed which is projected on a convex inclined screen. This screen may be transparent or opaque, dependent upon the position of the projecting apparatus, and this position is largely determined by the amount of space available. A concave mirror is placed in front of the audience which reflects the image formed on the convex screen just described. Inasmuch as the screen is placed between the focal point of the concave mirror and the mirror, the image is true and enlarged, not inverted, as would be the case if it were placed outside this focus.

Use is now made of certain peculiarities of spherical mirrors, which are usually considered as defects in the construction of some optical apparatus, such as telescopes, in that deformation of the image produced by the relative distance separating the screen from the axis of the mirror, develops a lack of similitude of the image simultaneously seen by both eyes, and because of the different distortions given to the image by the spherical mirror, stereoscopic results are obtained. The audience appears to see the image well back of the mirror, and the position of both eyes with respect to distance to the spherical mirror being different, the position of the relative images as they appear in back of the screen, differs widely, producing in this way the stereoscopic effect.

Unfortunately, every stereoscopic motion-picture machine, regardless of how accurately it is built, does not develop perfect pictures, as is often claimed, and stereoscopic pictures fatigue the eye. The writer, having recently viewed several stereoscopic reproductions, has found this to be true, the prime factor responsible for this is the attempt of the eye to accommodate itself to the varying distances of these images. A simple experiment can be made by anyone to determine how tiresome even an entire performance of this nature would be, by placing a picture in front of him and another at a relatively greater distance from him. Now shift the gaze rapidly, so that the details of both pictures will be seen, accommodating the eye to the picture in the foreground, and then to the picture in the distance.

Nevertheless, stereoscopic motion pictures are beautiful to look at, and seem to be real, apparently leaving the screen entirely and projecting themselves out into space immediately in front of the observer.

Several theatres will soon open, featuring as portions of their programs, stereoscopic moving pictures



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Electric Primer for Cold Weather

(*Continued from page* 868)

wire. Put the looped end of the wire under the screw head and screw up the nut to hold it firmly.

This whole assembly, with wire attached, is first screwed into the tee. For this resistance coil any convenient resistance wire, such as "Climax" No. 18 B. & S. will do. Find by experiment the length which will take twenty amperes from a six-volt storage battery. To do this connect a foot or so of the wire in series with an ammeter and to the battery. This can probably be done without removing the ammeter from the dash. Shorten the amount of resistance wire in the circuit until the ammeter reads twenty amperes. This should be heated to a bright glow in ten to twenty seconds. Coil this into a spiral of suitable length by winding the wire over a small rod.

Next slip the porcelain tube (3-inch radio lead-in) into the bottom of the T and screw in the pipe nipple over it. If a porcelain tube is unavailable use stove-door mica rolled into a tube.

The bottom part is probably the fussiest of the whole job, since the machine screw which serves as the terminal must be insulated from the rest of the primer and also must not cause leakage of gasoline. Get at the hardware store a few fibre packing washers which will fit inside the ½-inch screw cap. The screw is any convenient size which will fit snugly the hole in these washers. A hole is drilled through the middle of the cap larger than the screw diameter. Twist the end of the resistance wire under the head of the screw. Slip a small, flat metal washer over the screw, then a fibre washer and then the cap. Hold the bottom end of the screw carefully while the cap is being screwed to the nipple. One of the fibre washers cut down to the inside diameter of the hole in the cap and a larger fibre washer placed outside it. A nut is next run on and screwed tight with a wrench, while the screw is kept from turning by being gripped by pipe pliers. Paint or shellac should be used on the washers, etc., to insure points which will not leak.

To operate, fill the priming cup from a squirt can, enough times to fill the heating coil chamber nearly up to the side opening. Then with the cock closed, the current is turned on—one side of the battery being connected to the bottom terminal post and the other grounded. In a few seconds a heavy vapor of gasified gasoline will begin to flow out through the side opening into the inlet manifold.

Contributed by J. T. LANSING.

COUNTING HUMAN HAIRS

After counting all the hairs on the heads of the students, two professors at the university in Munich, Germany, found that men have from 40,000 to 50,000 hairs on their heads, while women have from 60,000 to 70,000.

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Daylight Moving Pictures

By MAURICE E. PELGRIMS

(*Continued from page* 861)

screen itself is placed midway in what, temporarily, is a sort of long wooden tunnel. The visible opening presents an area of about seven feet square. The particularly interesting property of the dark chamber of remaining entirely dark despite the luminous beam projected by the apparatus through the screen and the daylight arriving from the surrounding open space, is also quite noteworthy. This visibility is rendered so acute under the circumstances, that the texts appearing between scenes may be read with ease at a distance of 200 feet.

Winners of Loud-Talker Contest

(*Continued from page* 912)

FIFTH PRIZE

By T. Mackie

This loud-speaker is built almost entirely from a Ford horn. First undo the six bolts around cap of horn. Before taking the sections apart make a scratch on each directly opposite each other to aid in assembling. Take the sections apart and remove the iron diaphragm. If the windings of the magnet coil are burned out, re-wind with the same size and same length of wire as was originally used.

The next operation is to wind the moving coil. This is wound on a core ⅜ of an inch in diameter between two fibre pieces, placed ⅛ of an inch apart. Wind some fine wire from a spark coil secondary. No. 40 enameled, to a depth of about ¼ of an inch, leaving leads 2 inches long. Carefully remove from form and soak in shellac, then lay aside to dry.

Cut out of thin mica a diaphragm of the same size as the original iron one. Cut two rings of very thin cardboard, of the same outside diameter as the diaphragm and about ¼ inch wide. The horn is now ready to assemble. Place the fine wire coil in the exact center of the mica diaphragm, use a little glue or shellac to stick it there, then clinch it in position with a piece of copper wire (see Fig. 1) passed through holes drilled in the mica. Place a cardboard ring on each side of the mica and attach with a little glue. Drill two ¼ inch holes near the horn terminals, and through these put two small bolts, insulated from the frame with fiber washers (Fig. 2). To these solder the lead wires from the moving coil. Now lay the diaphragm and coil in position on the horn, the coil on the side nearest the magnet and see that the leads are placed all right. On top of the diaphragm place the cap (Fig. 3) so that the scratches are opposite each other. Hold the sections tightly together and drill through the six holes with a ⅛ inch drill to remove the cardboard and mica therein. Fasten on cap and support with bolts.

For the base use a piece of wood 7 x 9 inches. Cut a slot 3 inches long and ⅛ of an inch wide, parallel to and ¾ of an inch from one of the ends. Drill a ¼ inch hole 2⅝ inches from each corner into this end. Into the slot set the horn mounting and fasten in place with wood screws put through these two holes. Mount binding posts and switch as shown in the photograph and connect as in Fig. 4. Run the connecting wires in grooves in the base.

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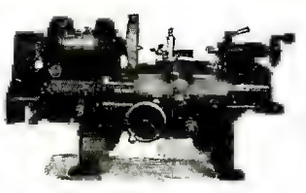

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Radio Wrinkles for Those Who Build Their Own

By A. P. PECK

(*Continued from page* 882)

be connected from the grid lead to the filament, the exact position being left to the constructor. The generally accepted place for the grid leak is the former, but the latter connection has often been found most efficient.

In choosing his panel and deciding whether or not he shall shield the same, the amateur is often confronted by conflicting opinions. We therefore mention below several ways of constructing and shielding panels, and will leave the choice to the constructor's taste or size of his pocketbook.

There can be purchased on the market a composition panel in the center of which is moulded a copper screen. This screen, of course, is placed there in order to shield instruments from the body capacity of the operator. In using this type of panel, it is necessary that all the holes drilled through the panel be bushed with some form of insulator. Of course, all the necessary holes must be drilled larger than required, so as to allow for the thickness of the bushing. This is illustrated in Fig. 4A.

Some amateurs purchase fairly thick hard rubber or bakelite panels, and then place aluminum sheet in back of the same for shielding purposes. To the writer, however, this seems to be a waste of money. Why not purchase a thin panel or hard rubber or bakelite, say 1/16 of an inch thick, and use 1/16 inch aluminum as a backing for the same. The aluminum will serve a two-fold purpose; namely, that of strengthening the thin panel, and also of shielding the instruments. In this case, as in Fig. 4A, all the holes drilled must be bushed, and the bushing must extend at least 1/16 of an inch through the back of the panel. Over this extension a fibre washer is placed. This is to insulate the parts projecting through the bushing from the aluminum sheet.

In Fig. 4C we show the rear view of a panel which may be constructed of any insulating material, and is then covered with metal foil, which may be fastened to it by means of shellac. Before it is fastened, however, all the holes that are to be drilled in the panel must be laid out on the foil and larger holes cut therein. The only place where it will not be necessary to cut a larger hole than that in the panel, is where the ground post is to be placed. This is done so that the ground connection will touch the metal foil, thereby of course, connecting the same to the ground, which is very desirable in producing the shielding effect.

Very good looking panels may be made of polished hard wood, but their insulating qualities are not very high. However, many amateurs use them because of their cheapness, and are willing to sacrifice efficiency for this reason. They need not make this sacrifice, however, for, by means of pieces of scrap bakelite, they may make their panels as efficient as one constructed from a large piece of insulating material. This is done as shown in Fig. 4D. Where it is desired to place a switch, a square hole is cut in the panel and a small piece of bakelite, slightly larger than this hole, is obtained. The latter is drilled for the switch points and arm and fastened directly over the square hole cut in the panel. In this way none of the metal

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Don't Blame It on Static!

THE REAL EXPLANATION OF MUCH OF THE TROUBLE YOU HAVE WITH YOUR RADIO SET.

By J. C. Shaw

One of the things which the radio world is rapidly learning is that the term "static" has been very loosely used to cover a multitude of radio sins for which static is really in no way responsible.

It is discovering that many of the frying, crackling noises and much of the so-called interference laid at static's door are due to nothing more or less than **the use of batteries of the wrong kind or that leak an excessive amount of electricity**.

Any one of these battery faults can undo the most careful work in construction of set and aerials, and usually not only one but two or three of them are present in the same place.

Radio operators should remember particularly that "B" batteries are in series with the phones or amplifying horn and that any noises set up within the "B" batteries themselves will come in strong. You can demonstrate this to yourself by scratching your "B" batteries with your finger-nail. The noise you get through your phones will surprise you.

A growing understanding of these facts is leading to much greater care in the selection of batteries and to the use of high-grade storage batteries for both A and B work, since such storage batteries have just the characteristics needed for both efficiency and economy in radio service.

An interesting development in this connection is the new type "B" battery and an all-rubber "A" battery put on the market by the Willard company. In these batteries, electrical leakage, which is present to such a great extent in the ordinary battery and which accounts for so much noise, is to a great extent ingeniously overcome.

The "B" battery cells are cylindrical glass jars with hard-rubber, screwed-on covers. These are so spaced that the only contact between cells is through heavy, burned-on connectors. No sealing compound is used and the box is cut down so that the sides reach up only about half way to the tops of the jars.

These features and the use of threaded-rubber insulation, operators find, result in a battery which holds its voltage and, with occasional recharging, lasts for years. The writer has seen this Willard "B" battery in use on different sets and has been greatly impressed with the way it adds to range and power and cuts out noises.

Inasmuch as this big improvement can be effected at an actual saving of money because of the long life of a really good storage battery, there is no question that this type of battery will rapidly be adopted for a great majority of sets. When this is done, the bugaboo of "static" will lose much of its terror.—(*Advertisement*)

parts of this set touch the wooden panel, Very neat effects may be obtained by bevelling the edges of the strips slightly. The effect obtained in this way is similar to that obtained in using the unit sets put out by certain manufacturers which are so popular with some amateurs. In the case of binding-post holes, these should be bushed as is also shown in Fig. 4D. These bushings must be turned up with a flange on one end in a lathe and after they are inserted in the panel, an insulating washer is to be placed over the other end.

There are certain experimenters who prefer the so-called isolated instrument way of setting up a receiving set. For this work a suggestion is given in Fig. 4E. All the instruments which have to be controlled in the course of receiving, are mounted on small insulating panels and set up on the front of a wooden base as shown. The other instruments, such as the tubes and transformers, are placed in the rear. On the back of the baseboard may be erected several strips of hard rubber or bakelite with slots cut in their edges with a hack saw, as shown. These strips are used to support the wiring, and are very handy to prevent short-circuiting of the different connections which must necessarily cross quite close to each other. By using these strips, bare wire may be employed without the attending fear of short-circuits.

One of the neatest styles of radio sets for home use, which has come to the writer's attention, is that illustrated in Fig. 4F. The form is somewhat similar to that of a phonograph cabinet, but by lifting the top, the interior of the set is revealed. Any amateur with a little woodworking experience should have no trouble in constructing a cabinet for this type of set. The controls are set slightly back from the front of the cabinet and two doors are provided, which cover these controls when not in use. In the lower compartment, which is also closed by means of doors, the "A" and "B" batteries are kept. The entire set stands at a height of about 4 feet from the floor, and as the "Adv" writers aptly say, "Would prove to be an ornament to anybody's parlor."

For those who employ the old style tubular valve, a surprise is in store, providing of course, they have not already learned this trick. It is the utilizing of permanent magnets or a winding of wire on the exterior of the tube to produce a magnetic field, which in turn concentrates the flow of electrons within the tube, thereby increasing the volume of the received signals This is illustrated in Fig. 5. A large permanent steel magnet may be used, and various positions of the same in relation to the tube should be tried. The writer tried using a winding of about fifty turns of No. 22 DCC magnet wire in the center of the tube, connected in series with a 6-volt storage battery, and a 6-volt, 8 candle power lamp. Better results were obtained by inserting a rheostat in the circuit so as to control the flow of current through the winding. When these stunts were tried on the up-to-date four-prong tubes, very litle success was gained, but the writer would be glad to hear from any amateurs who are able to increase the efficiency of their tubes by this method.

How many times have you left your tube set with the filaments turned on, and not discovered it for several hours, much to the detriment of your "A" battery? This trouble can be eliminated, providing of course that you use phones and not a loud-speaker, as shown in Fig. 6. A hook switch projects through

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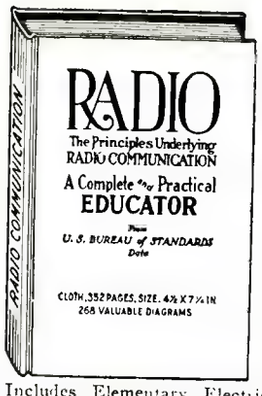
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the front of the panel on which the phones are hung when not in use. By hanging up the phones, the hook is pulled down, and two springs in back of the panel are separated, thereby breaking the "A" battery circuit. Most of the parts necessary for constructing this switch can be obtained from an old telephone.

Now here is one for the crystal radio "fan." Before we describe it, we want to give a piece of advice, and that is, buy your crystal in bulk. Half pound lots of galena may be purchased for the price of two or three mounted crystals, and will in almost every case yield many sensitive pieces, some of which are often much better than those purchased already mounted. In Fig. 7 is shown a device which makes easy the testing of large quantities of crystal. A wooden base is obtained about 5 inches long by 4 inches wide, and a piece of copper or tin foil is fastened thereon as shown A binding post is also provided, which makes contact with this plate. On the other end of the base is fastened a binding post to which is connected a piece of flexible wire about 16 inches long. To the end of this wire is soldered a piece of brass wire about No. 10 or No. 12, the other end of which is filed to a point. Several layers of tape are now placed over this brass wire to serve as an insulated handle. Now to use this, connect it in the receiving circuit in place of the detector. Place a quantity of galena or other crystal which has been crushed into pieces about 3/8 of an inch cube on the plate and turn on the buzzer test. With the pointed brass wire, go carefully over each piece of mineral and a thorough test can be given very quickly. Of course, it will not be necessary to use the buzzer test if your set is tuned to the wave of some transmitting stations, and you are sure that they are in operation.

Well, fellow "bugs," there you are; go to it, and let us know of any other stunts or kinks that you may discover.

Radio for the Beginner

By ARMSTRONG PERRY

(*Continued from page* 886)

today you can buy the stator, or outside cardboard tube for a dime; the rotor ball for a quarter; the shaft and knob for about a dime apiece and wire enough for the windings for a quarter. The winding is not a difficult matter and it is unnecessary to waste words in description, because the plans show it so clearly. Careful pains taking work is essential however. The use of the variometer saves about twenty switch points that are required to receive the wires from a tapped coil, but the tapped coil may enable you to tune to a greater range of wave lengths. If switch points, tongues and knobs are needed they can be purchased for from five cents each upward. Solder, which is needed for making good electrical connections can be purchased in paste form and melted with a match.

After passing the tuner the current goes through a detector, which is usually a piece of galena or an electron tube. Any device that will hold a galena crystal in fixed contact with one wire and in variable contact with another will answer the purpose. In fact I sometimes hold the crystal in my fingers, with no mechanical device whatever, and touch it with the antenna wire but this is not good practice for it is impossible to maintain the steady pressure needed for good results and contact with the skin may destroy the

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crystals sensitivity. At the present price of crystal detectors and parts it is hardly worth while to spend time building one except for the purpose of keeping busy and getting experience. Fifty cents will buy one complete, crystal and all. The plan shows where and how to attach it to panel or base.

Some plans call for one condenser, or more, fixed or variable. Others do not. Condensers can be purchased complete for from sixty-five cents to five dollars or more, according to type and size. As there are many types designed for a variety of purposes it is as unwise to order a condenser without naming the type and capacity desired, as it is to order an automobile without specifying what kind you want. At the five-and-ten I can buy condenser plates at a nickel each, bases, shafts, separators and all other parts and assemble a condenser to meet the requirements of my plan. The location of condensers in the circuits are always clearly shown on the plan. The types and capacities, if not indicated, can be learned by asking questions.

The last piece of apparatus that the current passes through is the phone. Phones come singly or in pairs and the price now is from $2.50 to $10.00 apiece. You will hear more with a good phone than with a cheap one. The current goes in one tip of the phone cord, through the phone and out the other tip. The tips are secured to binding posts or other efficient contacts. The outgoing current goes over a wire to a binding post marked "Ground." From there it goes over another wire to a water pipe or some other metal that goes down into the ground. The energy is transferred from the ground back to the antenna, in part, thus completing a circuit. Electricity will not flow unless by some means it can return to the point whence it started.

A simple crystal detector receiver can be changed into an electron tube receiver by substituting for it a vacuum tube. The tube must have a socket which will hold it in place and provide a means for connecting the three metal parts within the tube with wires outside. It must have one battery to light its filament and another to place a pressure, or potential, upon its plate. The current from the antenna goes to a third part called the grid. An enlarged plan is needed for the addition of the tube to the crystal detector set. While the action of the tube is even more complicated than that of the crystal and tuner, a novice can build and operate a tube set if he can read and follow a plan.

Those who live more than ten miles from a broadcasting station may as well tackle the tube set at the start. A crystal frequently brings in stations twenty-five miles or more away. I have picked up code with a crystal from stations two hundred miles away. Marconi received his first transatlantic signals without a tube. But if you depend upon a crystal for long distances you must have a very much better antenna and ground connection than most stations have.

It is better for the beginner to consider a number of plans and select one adapted to his circumstances, than to take the first one suggested by a man at a distance who has no knowledge of local conditions. The experienced radio man can order parts with reasonable assurance that he knows what he wants. The beginner gets along faster and better if he can visit a local store

to buy parts and get advice. One of the first steps in radio should be to look around and read books, pamphlets and magazines until the names and functions of the various pieces of apparatus become familiar. That saves waste of time and money.

Plans for building receivers can be purchased by mail from many reliable concerns. This magazine publishes wiring diagrams and construction details for many types of receivers that a beginner can construct. It also gives free advice by mail on the difficulties encountered.

Like others who give advice to beginners I am often criticized by radio experts for encouraging the use of cheap apparatus. A man who is giving his life to developing a receiver that will bring in music with all the volume and quality that it possesses where it is produced, and who has brought his inventions to a surprising state of perfection, has just taken me to task for using and suggesting the use of the crystal detector, though the music he broadcasts comes to me through a ten dollar outfit—yes, even through a Boy Scout's twenty-one cent outfit—in a way that is entirely satisfactory to me. He reminds me that persons who once were thrilled by hearing a lecturer bark into a phonograph using a sheet of tin foil for a record and then hearing the machine reproduce the bark, are now satisfied only with the most modern phonographs costing hundreds of dollars. "And who would buy a spinnet, now that we have pianos?" he asks.

I see his point of view, and you will too. Progress toward perfection is the thing that distinguishes man from lower animals. But sticklers for perfection forget that no man is born full grown, either in body, mind, or appreciation. A boy will rip the ivory off the keys of a thousand dollar piano without a thought of the sacrilege he is committing against a long line of highly developed men who made the marvelous instrument possible. Then he will turn around and fight the fellow who scratches the panel of the dollar radio outfit that he made himself. He cannot appreciate the wonderful thing that others have made, but he can appreciate the crude thing that he made himself.

Men are but children of an older growth. Some of us, through experience in other matters, can appreciate to some extent a highly perfected radio outfit. But most of us get more fun out of the simple receiver that we build or assemble with our own hands. It teaches us respect for the better apparatus, just as trying to chin ourselves on the limb of an apple tree teaches us respect for the vaudeville acrobat who gracefully and without apparent effort achieves a series of giant swings and a flyaway.

Persons, who have plenty of money and no ambition to exercise their muscles and their gray matter, do well when they buy the best and most expensive apparatus on the market. Eventually the beginner who builds makes a better customer for the radio manufacturer and dealer for his interest grows while that of the passive listener fades. Above all, the beginner who begins even in the smallest way will get more out of radio and more out of life than the fellow who sits down and waits for someone else to hand him a fully-developed outfit.

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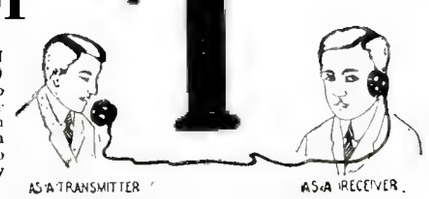

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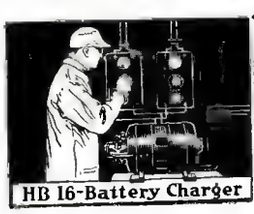

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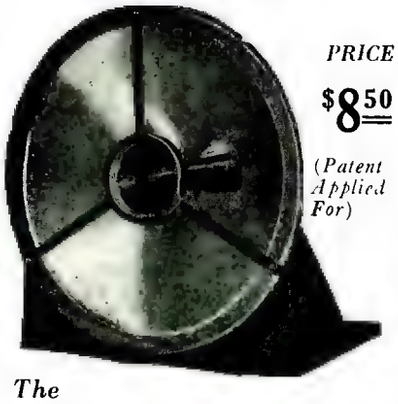

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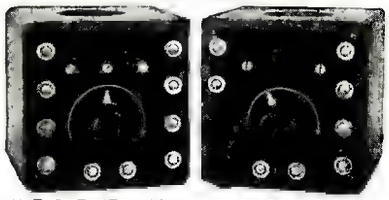

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Factory: Lynbrook, L. I

That First Radio Set

By MIKE R. FARRODS

(*Continued from page* 883)

bicycle pump. The base was made from a piece of dry cedar and after giving it several coats of shellac, it had the appearance of dark mahogany. I had no thin lumber available for a panel, as box lumber was either too thick or warped badly. I had about given up, until in desperation I went through the old phonograph records, and selecting the largest and thickest, I squared it up and laid out the positions for the switch points, shafts, and binding posts. I tried drilling the holes and found that the drill chipped and flaked the record, so I went back to first principles and used the hot tang of the file, pushing it through until the hole was the right size. I conceived the idea of making the holes for the split rivet switch points slightly undersize, and pressing the rivets in with a hot iron; this worked like a charm, and when cold, the rivet was held firmly in the hole. The leads from the primary were then soldered to the split end of the rivets, making a very neat job. The switch was made up from odds and ends from the junk box. The spring brass arm was cut from a nickel plated shaving stick holder.

My primary and secondary condensers were of the book type. I used the top of a veneer tobacco caddy, upon which to mount the tinfoil, which came from the same source. I next dissolved the scraps from the phonograph records in denatured alcohol, and after straining through cheese cloth to remove the bits of paper and fibre, I applied several coats to the veneer parts of the condensers, and the result was a dead black insulating finish resembling bakelite. The phone condenser was made from tinfoil, and wax paper. After it was made up I gave it a coat of black varnish and placed it between two pieces of record large enough to cover it, and allow the two strips of shim brass (a thin sheet brass used as spacers in auto bearings), to extend outside to make connections. I baked the whole thing until it was plastic, and then pressed between two flat-irons, until the thing looked like its picture in Skinnem & Robbem's radio catalog. I then mounted it on the panel.

The next problem was a crystal detector stand for panel mounting. A small brass grease cup, one-half inch brass strips from a hanging lamp, a gasoline needle valve, and an enameled copper wire cat-whisker, evolved under patient drilling, filing, and twisting into a thing of promise if not of beauty. Now this labor occupied my evenings at home for the best part of two weeks, yet no word from the two towers. So I wrote them a saucy letter, advising them that the air was full of radio, also I wanted my phones and galena, and if they couldn't supply galena, I would be happy to get one of the 57 varieties that were being substituted. They advised me that the mines were unable to produce enough galena to meet the demand, and that unless Henry Ford commenced making phones, I would be several years older before I made connections.

I read the letter and cranked my Lizzie and made a quick trip to the Government wireless station, with bribery as my motive. The operator, however, informed me that the one and only piece of carborundum on hand was now in use. Also, one set of phones was all that a station was allowed, and from the casual glance he bestowed upon that hard earned twenty dollar bill, I knew my trip was hopeless. What I apparently needed was influence, pull, so I appealed to

Choke off that "squawk"

AFTER all it is not always the bad vaudeville actors that "get the hook." Many owners have found an efficient hook to choke off the "squawk" of their radio sets and secure enjoyable music by adding Acme *Audio* Frequency Amplifying Transformers to the ordinary detector unit. Acme Transformers cost but five dollars, yet the results are almost marvelous. Not only do they amplify sound, but they bring it naturally—realistically. They are necessary to the proper operation of the Acme Clear Speaker which enables a whole roomful of people to enjoy the broadcasting concerts.

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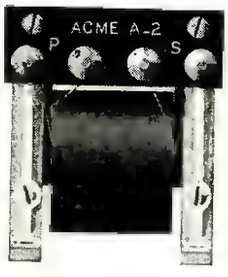

Type A-2 Acme Amplifying Transformer,

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ACME

for amplification

an ex-operator for help. No chance, but he loaned me a book that was full of formulæ and wave meters. I studied it, carefully skipping the formulæ, figures and signs, and thereby discovered that you did not need a crystal at all; a platinum wire fused in glass, a cup filled with nitric acid, and you had an *electrolytic rectifier*. Great—but I was just out of platinum, either plain or glass coated. At about this time I bought a copy of RADIO NEWS. Here I found a description of an electrolytic rectifier for charging storage batteries. This one, however, used lead and aluminum plates. So I planned a miniature lead and aluminum rectifier. I changed the cat-whisker from copper to lead, used soda in the cup with an aluminum foil lining, and wrote again for phones. I got my money back, but no phones. I just had to have a pair of phones! I again took an interest in the book on wave meters and found a picture of a typical phone "with its clothes off," and an itemized list of its working parts. What I required then was simply a permanent magnet, a coil or two of fine wire, a laminated core, a diaphragm, cases, and cord. I got a Ford magnet from the garage man, and with some stove pipe iron and a pair of snips, I constructed an "E" shaped core; the finest wire I could find at that time was some No. 24, left from winding the coils. I made a paper spool to fit the center pole of the "E" shaped core, and after winding on about ten layers of wire, I slipped it in place on the core. I now assembled the parts by simply allowing the permanent magnet to support the core, in such a way that the two outside ends of the core were held at the ends of the magnet, the center pole of the core containing the coil, being in the exact center of an imaginary line drawn from one end of the magnet to the opposite end. I supported the magnet on the base of the crystal set and connected the wires to the two binding posts marked "phones." Then I placed a compass on the Ford magnet over the center pole of the "E" core, and tuned. Absolutely nothing happened. Now if I had some galena, platinum wire, or even a carborundum scythe stone—but I had neither. I went through all the boxes and drawers, and came back with a can of silicate of soda (water glass), bought originally to preserve eggs, and a bottle containing mercury. I poured some drops of mercury into the cup that had waited so long for the cheering whistle of galena, and on top some drops of water glass. I brought the lead strip cat-whisker into contact with the water glass and tuned; not yet—so I changed the lead to aluminum and tuned some more; still no results.

The book of formulæ was consulted and I returned to the scene of battle with my six-volt auto starting battery, and hook-up for carborundum; when the connections were made I tuned, then I put in a drop or two of water, and a little soda. I tuned the knobs again, suddenly the compass began to shimmy, stopped, shimmied; long and short shimmies.

The ex-operator passed, I called him in, and together we watched. Again it commenced. "Where's your can?" he asked. I wasn't up on radio slang, and mistook his meaning. I reached for my Velvet—the can was empty. "Your phones," he said. "Haven't any," I replied. I removed the compass, and opening the Velvet can I laid it flat over the poles of the "E" core, and at my exclamation of surprise, he yelled, "Shut up, it's Morley, he's calling Destruction Island." "What kind of a crystal is that?" he asked. "That's Variety 58, an invention of mine," I explained proudly. "There—Destruction Island is answering." Then I became conscious of a loud sputtering from the Velvet can loud-speaker. I looked for the trouble and found the secondary coil was quite warm. I touched it,

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Diameter of Shaft ⅝".
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Ball-bearing armature.
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What You Can Do With This Generator

TO catalog all the uses to which this generator can be put would take a whole newspaper page. All we can do here is to suggest a few outstanding uses. A multitude of others will quickly occur to the man or boy whose mind runs along mechanical and electrical lines.

It can be employed as a generator for a small lighting plant when belted to a 1 H. P. gasoline engine, thus affording current to light 20 to 30 12-volt, 4 C. P. automobile type of lamps, or 10 12-volt, 21 C. P. automobile lamps.

As now wired, it will charge a 12-volt storage battery.

Can be used on motor boats for lighting and ignition.

At 3,500 R. P. M., driven by ¼ H. P. motor, or by gas engine, water wheel, wind mill, etc., it will charge 6-volt storage cells.

Makes an excellent electro-plating generator.

If armature is re-wound it will charge a 6-volt battery at 1,750 R. P. M., or light 6-volt lamps at that speed.

It can be re-wound as a 500-volt generator for radio transmission.

It can be used as a D. C. motor, 110 volts, if re-wound—or on 13 volts as it now stands.

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it was hot and sticky. I disconnected the battery, but it was too late—I had burned out my secondary winding.

This is a true account of the making of my first radio receiver. Since then I have tried out a great many of the freak hook-ups in RADIO NEWS. Some of them worked as they lay—some of them didn't. But with the aid of that book of wave meters and formulæ, I have been able to work them over and correct mistakes in drawing or values. I now own a wonderful pair of Baldwin "cans," besides a few choice tubes and rheostats. The rest of my equipment is home-made. I have received from every station on the Pacific Coast and from the Hawaiian Islands. But some time in the near future I am going to go back and recreate that Velvet can loud-speaker and electrolytic detector, and write you a prize-winning description of it.

Photos with Polarized Light

By PROF. LINDLEY PYLE

(*Continued from page* 861)

copiously than the light of long wave length. Furthermore, scattered light is in general plane polarized, that is, its vibrations are largely confined to one plane, and such light is reflected only sparingly by a water surface under certain conditions of incidence. In other words, so far as the final result is concerned, the water surface under proper conditions will play the same role as the yellow glass plate attachment for cameras known as the "sky filter." The photographically active light of the blue end of the spectrum is absorbed by the glass plate filter in the one case and is refused reflection by the water surface in the second case. Thus the sky tends to photograph black, and the white clouds show up against the dark background.

In experimentation a glass surface may be used instead of a water surface, since it offers a wider range and ease of manipulation. Take a piece of plate glass at least a foot square and make of it a *black mirror* by giving it a backing of flat-black paint. This prevents extraneous light from coming to the eye from objects behind the glass and prevents any image formation by internal reflections from the rear surface. Make a sloping cut across a lead pencil and glue it to the face of the mirror so that it makes an angle of approximately one-third of a right-angle with the mirror face (Fig. 2).

Assume that the sun is overhead on a day when the sky is not overcast with clouds. Hold the mirror so that the pencil is directed toward a point in the sky close to the horizon and gaze intently into the mirror at the image of the chosen point, meanwhile rotating the mirror into all posible positions consistent with the requirement that *the pencil shall continuously point at the chosen spot in the sky.* (This means merely that the pencil twists but does not change its direction.) In one particular position of the mirror the sky will grow very dark and any clouds in the vicinity will stand forth in marked contrast. This optimum position corresponds to the case when the plane of the mirror stands vertical, that is, when the plane of the mirror passes through the sun. In this position the particular kind of light that comes from the sky is absorbed rather than reflected. These so-called polarization effects are most marked in those regions of the sky situated 90° from the sun.

When the sun is near the eastern or western horizon, that part of the blue sky yielding the greatest proportion of polarized light lies on a line drawn through the zenith from the northern to the southern horizon. In this case, holding the mirror so that the pencil is directed toward some point in this region of maximum polarization (which is 90° from

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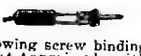

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the sun), the chosen spot in the sky as seen in the mirror will appear darkest when the plane of the mirror passes through the sun,—just as in the other case. In fact, this is a rule of position that holds in all cases.

Now, Mirror Lake in the Yosemite is usually photographed early in the forenoon when the surface of the water is smoothest. The light from the low-lying sky in the position north-northeast should then be most markedly polarized. A glance at the map of Yosemite Valley shows that the accompanying photograph was taken toward the northeast and the shadows in the photograph verify the assumption that the exposure was made in the early part of the day. Furthermore, a water surface is most sensitive as a detector of polarized light when the light makes an angle of 37° with the reflecting surface. The light coming from the sky above the mountain top approximates to this angle. We conclude that the remarkable cloud effect in the water is essentially a polarization phenomenon.

To obtain further experimental evidence a camera was equipped with a black mirror as in Fig. 3. The mirror was mounted so as to permit rotation, while at the same time always inclined to the axis of the lens system at the proper angle. This angle is such that the light entering the camera makes an angle with the mirror of 33° (approximately one-third of a right angle). A plate glass surface is most sensitive as a detector of polarized light under these conditions.

By manipulating the mirror, photographs No. 4 and No. 5 were taken of a certain cloud formation with those two positions of the mirror reflecting respectively the least and the greatest amount of sky light. The negatives and prints were given identical photographic treatment. The contrast of cloud against sky is noticeably greater in No. 4.

Photographs No. 6 and No. 7 were made with the mirror-equipped camera with the object of showing that, in general, reflected light is polarized and is reflected more or less copiously from a glass surface depending upon the orientation of this surface with respect to the incident light. The privet hedge extending across the center of the picture held a multitude of tiny glossy leaves that reflected the afternoon sunlight. The black mirror transmitted this reflected light with ease in one position, Fig. 6, but refused to reflect it in another position, Fig. 7, absorbing it and extinguishing it. Although both photographs received identical treatment as to exposure and development, the one turns out to be dull and sombre while the other is bright and sparkling. Fortunate we are that the eye transmits light in all planes of vibration with equal facility, so that under direct vision there is no selective act on by the eye and Nature always appears at her brightest

Practical Chemical Experiments

By PROF. FLOYD L. DARROW

(*Continued from page* 870)

as long as the action continues. Good lime will leave less than 10 per cent of insoluble matter.

In the preceding articles of this series numerous tests of direct importance to agriculture have been given. Some of these are the Babcock milk test, the detection of formaldehyde in milk, the distinction between oleomargarine and butter, and tests as to the purity and hardness of water.

In the next article of this series we shall take up the chemistry of dyes and mordants.

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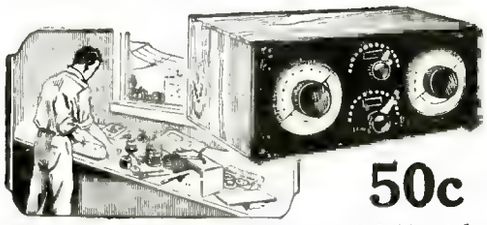

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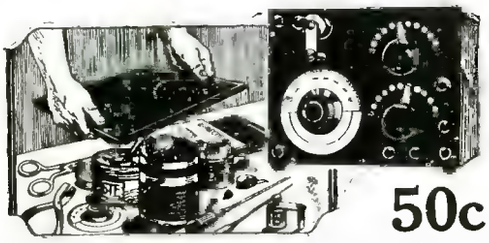

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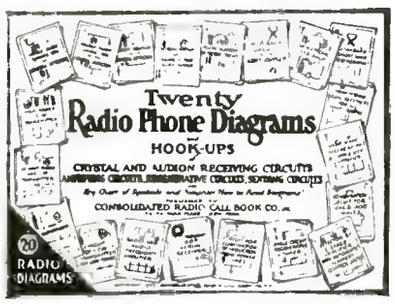

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THE Radio Specialty Company, "RASCO" for short, is probably the most unique radio parts supply house in the United States, if not in the world today. This Company makes a specialty of **SMALL ORDERS.** No order can be too small to get immediate and prompt attention, for the simple reason that **most of our orders are small.**

The reputation of this Company was built solely on service. Ask any of your acquaintances what they think of "RASCO" goods, "RASCO" service, "RASCO" promptness! Thousands of unsolicited testimonials on file prove that we serve the public best!

Many houses claim that their orders are shipped within twenty-four hours. A year's record in our Order Department actually shows that over 99% of our orders leave within **twelve hours** after receipt. We invite you to try "RASCO" service on a 50c order. **MAKE US PROVE WHAT WE SAY.**

Sixty-eight per cent of all of our customers come back for more goods after they have tried our service once. The reason is very simple, as we specialize in very small orders. We could not stay in business if we had to look for new customers continually.

"RASCO" SERVICE IS WHAT COUNTS!

"Rasco" Catalog No. 8

The new "RASCO" catalog, No. 8, will prove a revelation to the man who "builds his own." In this catalog are listed more parts and more items than you have previously thought possible to obtain.

The new "RASCO" catalog contains over 500 different radio items, and has been greatly enlarged over the preceding one. **IT NOW CONTAINS 64 PAGES, INSTEAD OF 40.**

Price Reductions

Many items have been reduced to give our customers the benefit of the lower prices that enlarged production makes possible.

Factories in Brooklyn, N. Y., and Elkridge, Md.

These two factories, where our screw machine work, our stamping and our composition work is turned out, make it possible for us to offer the very lowest prices in the country.

75 Vacuum Tube Hook-Ups!

These hook-ups of **ALL** important vacuum tube connections are given in clear diagrams with complete explanations. This is the one and only catalog containing such a wealth of information on all Vacuum Tube sets, giving all the correct values of all the elements, so that any amateur can readily hook up a set with the instructions furnished.

All Armstrong Circuits: These important circuits are explained clearly, all values having been given, leaving out nothing that could puzzle you.

Just to name a few of the Vacuum Tube circuits: The V.T. as a detector and one-step amplifier; regenerative circuit: DeForest ultraudion; V.T. to receive undamped and spark signals; Armstrong circuits; one-step radio frequency amplifier and detector; three stage audio-frequency amplifier; short wave regenerative circuits; V.T. radio telephone; 4-stage radio frequency amplifiers; radio and audio frequency amplifier, inductively coupled amplifier; Armstrong superautodyne; radio frequency amplifier and crystal detector; combination V.T. detector one stage amplifier; two stage radio frequency amplifier and detector with feedback coupling (regenerative); regenerative receiver, using single spider web coil; Armstrong super-regenerative circuit; two stage radio frequency amplifier coupled to a two-circuit tuner, using two-slide tuner regenerative receiver; two stage audio-frequency amplifier, using crystal or V.T.; one stage radio frequency detector, two stages audio-frequency with feed-back coupling to first tube; power amplifier with loud speaker; regenerative receiver and one stage amplifier for DX work; one stage radio frequency detector with feed-back coupling; very sensitive circuit with two stages of radio frequency and regenerative detector; one to ten mile radiophone transmitter; three stages radio frequency, two stages audio-frequency loop reception; crystal detector with rectification; one tube super-regenerative receiver; short wave regenerative receiver with two variocouplers, capacity-coupled tuner; trap circuit to eliminate interference; selective circuit to eliminate interference.

If you were to buy a book containing all of these 75 Hook-ups you would have to spend from $3 to $7.00 to secure the same information.

REGENERATIVE RECEIVING SETS

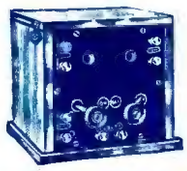
(LICENSED UNDER ARMSTRONG PATENTS)

WE PAY THE EXPRESS OR POSTAGE IN UNITED STATES, U. S. POSSESSIONS

RECEIVER AND DETECTOR

A beautiful solid mahogany regenerative set manufactured by C. D. Tuska Co. and licensed under Armstrong patents. Consists of Antenna inductance, secondary tuning condenser, plate variometer, coupling control, long and short wave switch, grid condenser, rheostat and tube socket. Engraved shielded bakelite panel and parts, metal parts nickeled. All parts are mounted on panel and cover is hinged to permit inspection and for replacing tubes. Wide range, 150-800 meters. The two stage amplifier shown to right matches this cabinet. Tubes, batteries, etc., are always sold separately; order from this page and save money.

ST222—Tuska Receiver and Detector $63.00
ST226—Tuska Two Stage Amplifier 36.00



DETECTOR AND TWO-STEP

Made in two sizes. The ST225 is a complete receiving set with detecting unit and two stages of amplification as pictured above. The ST224, consists of complete tuning and detector unit in shorter cabinet (see division of panel). Easily operated. Same high grade construction and finish as other Tuska sets described to the left. Ideal sets for concert reception. Tubes, batteries, etc., are always sold separately. Order from us and save money.

ST225—Tuska Receiver, Detector and Two Stage Amplifier Set $59.50
ST224—Tuska Popular Receiver and Detector Set 31.50
ST226—Tuska Two Stage Amplifier (shown in center) 36.00

GUARANTEED STANDARD PARTS AT LOW PRICES

Shipped in One Day—Order and Be Convinced

This Page Is Our Catalog—See Nov. and Dec. Also

PHONES

Genuine Frost and Brandes head sets complete with cords. Frost S162—Double head sets, 2000 ohm. $4.25
Frost S163—Double head sets, 3000 ohm. 5.25
Western Electric latest type double head set. List $12.00 Our price 10.50
Brandes Superior S166—Double head sets, 2000 ohm 7.20

LOOSE COUPLER

This loose coupler is preferred by many because of its wide range—200 to 3500 meters. Mahogany finish. All metal parts are brass, nickeled and highly buffed. Secondary has 12 point switch mounted on Bakelite coil head. Windings are green silk-covered wire.
S800—Size, 5½x6x18 inch. $6.50
S805—Two Slide Tuning Coil 2.60

FROST JACKS AND PLUGS

Jacks are polished nickel, nickel-silver springs, pure silver contacts. Nickel washers for mounting on any panel ⅛ to ⅜ inch thick. Spread terminals make soldering easy.
S133—One spring (open circuit). Each $0.46
S134—Two spring (closed circuit). Each .52
S131—Four spring (two closed circuits) Each ..... .63
S135—Three spring (two open circuits, commonly called "single circuit filament control"). Each ..... .70
S136—Five spring (two open and two closed circuits, commonly called "two circuit filament control"). Each ..... .88
S132—Plug, telephone type with short knurled grip ..... .35
S137—Plug (as shown), cord tips fit into plug 1.05
S139—Plug with threaded barrel instead of set screw. Takes cord tips ..... .55

CRYSTAL DETECTOR

A very high grade glass enclosed crystal detector including the crystal. All metal parts nickel plated. Adjustable to any point on the crystal.
S20—Enclosed crystal detector $1.40
A lower priced but nicely constructed detector. Crystal included.
S30—Detector ..... .88

TESTED CRYSTALS

Selected and tested galena or silicon. Each box contains enough for four to six ordinary crystals.
S12—Galena, per pkg. .$0.10
S13—Silicon, per pkg. .10

CABINETS

These are reasonably priced but sturdily built cabinets of weathered oak. The top is removable by loosening four screws. End posts are routed to take panel 3-16 inch thick. The panels are not included. See table for panel lengths.
S212—Can be used for detector and two step. Panel space, 5½x12 ..... $2.50
S214—Can be used for 2 variometers and 1 coupler. Panel space, 5½x14 ..... 2.75
S218—Can be used for 2 variometers, 1 coupler and detector. Panel space, 5½x18 3.00
S222—Can be used for 2 variometers, 1 coupler, detector and 2 step. Panel space, 5½x22 ..... 3.25

PANELS

Genuine Formica. Panels to fit our cabinets.
S262—Panel, 5½x12 inches 3-16" thick $1.38
S264—Panel, 5½x14 inches 3-16" thick 1.64
S268—Panel, 5½x18 inches 3-16" thick 2.08
S272—Panel, 5½x22 inches 3-16" thick 2.53

OUR GUARANTEE

Your satisfaction guaranteed. If for any reason you do not feel satisfied with your purchase, you may return it and we will refund your money plus return charges. We give you the benefit of any reduction in price.

VARIOMETERS

For efficiency, perfect inductive ratio, low capacity effect and neatness of design these variometers are unexcelled. All metal parts nickeled brass. Tight spring bronze contacts will wear indefinitely. Accurately turned rotors and stators, mahogany finish. Completely assembled and tested. Wound with two sizes of wire—No. 18 and No. 20.
S1300—Variometer, No. 18 wire. Price $2.75
S1200—Variometer, No. 20 wire. Price 2.75

AUDIO FREQUENCY AMPLIFYING TRANSFORMER

Correctly designed for minimum distributed capacity and low core losses, maximum amplification without distortion. Use 10-1 for Cunningham and Radiotron tubes, 3-1 for other makes. Fully mounted, cast aluminum feet, bakelite terminal panel.
S1510—Transformer, 10-1 ratio $3.55
S1503—Transformer, 3-1 ratio 3.50

RADIO FREQUENCY AMPLIFYING TRANSFORMER

Radio frequency transformer circuits help to eliminate static and interference, thus permitting easy, sharp tuning of long distance stations. Enclosed in metal case for shielding and can be mounted in tube socket if desired. Wiring diagrams furnished with each transformer.
S1500—Transformer. Each $3.95

"B" BATTERIES

Standard brands, France, Eveready or Burgess. Never over five days old.
S230—22½ volt Signal Corps type. Size, 3½x2½x2½ inch. Price ..$1.26
S235—22½ volt U. S. Navy variable—5 positive taps. Size, 5x3x2½ Price $1.98
S240—22½ volt large variable—5 positive taps. Size, 6½x4x3. Price 2.25
S245—15 volt large leads only. Size, 13x4x3. Price 3.80

INDUCTANCE COIL MOUNTING

For base or panel mounting. Connecting leads furnished, coil settings are adjustable by means of knobs. Made entirely of bakelite with nickeled brass metal parts. Coil position can be locked by knurled set screws.
S1603—Three coil mounting $3.90
S1602—Two coil mounting 3.00

BINDING POSTS

Complete with screw and washer. All brass, finished in polished nickel or with black composition top as listed. Order by number.

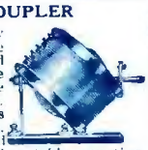
	Each	Doz.
S110—Large size, all nickeled	10c	95c
S122—Medium size, nickeled, with hole for phone tip or wire	4c	36c
S112—Medium size, black composition top	5c	48c
S120—Large size, composition top	8c	85c

SWITCH POINTS AND STOPS

Brass, polished nickel finish. Screw size, 6-32x5-8 ins. long, two nuts with each contact point and one with the stops. Stops high enough for any type of lever and point.

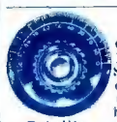
	Each	Doz.	Hundred
S130—Switch Point, diam., ¼ inch; height, 3-16 inch	3c	20c	$1.40
S150—Switch Stops	3c	20c	1.40

180° VARIOCOUPLER



The primary and secondary windings of this coupler are properly proportioned and spaced. The center of the secondary is always in the center of the primary field. Unlike most couplers, it aids in tuning. Black fire base, brown formica tube, and nickeled metal parts. Panel or table mounting.
S1100—Coupler $2.95

DIALS



Bakelite

Composition

Genuine Bakelite Dial as pictured. Sharply engraved divisions and figures filled with a brilliant white. Three-inch diameter, with bushing for 3-16-inch or ¼-inch shaft. Set screws included.

	Each	Doz.
S500—Dial	55c	$6.00

Three-inch moulded composition dial as pictured. Has a luster that cannot be told from Bakelite. Set screws included.

	Each	Doz.
S550—Dial, 3-16-inch Shaft	30c	$3.00
S555—Dial, ¼-inch Shaft	30c	3.00

VARIABLE CONDENSERS

Very best mechanical construction, heavy, hard aluminum plates. The vernier types are furnished with moulded dial and small knob for adjusting vernier. Plain types have ¼ inch shaft.
S1443—43 plates .001 Mfd. without dial. $2.35
S1423—23 plates .0005 Mfd. without dial 1.85
S1411—11 plates .00025 Mfd. without dial 1.35
S1403—3 plates .00005 Mfd. without dial 1.15
S1441—11 plates vernier .001 Mfd. with dial 4.95
S1442—21 plates vernier .0005 Mfd. with dial 4.25

SWITCH LEVERS

A high grade, polished nickel-plated lever with solid moulded black composition knob. Complete with panel bushing, spring and two nuts.

	Each	Doz.
S151—1" Radius	20c	$2.25
S153—1½" Radius	20c	2.25
S155—1½" Radius	20c	2.25

INDUCTION COILS

Rigidly wound, low distributed capacity. All coils are equipped with standard mountings. We can supply any of these coils without mounting plugs, for 55c less than the prices shown. The wave lengths shown are range limits, based on a variable condenser of .001 Mfd. capacity.

	Number of Turns	Wave Lengths	Price Mtd.
S1725	25	125- 250	$0.95
S1726	35	175- 450	0.98
S1727	50	240- 720	1.05
S1728	75	390- 910	1.10
S1729	100	500- 1450	1.14
S1730	150	600- 2000	1.19
S1731	200	900- 2500	1.28
S1732	250	1200- 3500	1.36
S1733	300	1500- 4500	1.38
S1734	400	2000- 5000	1.59
S1735	500	2800- 6100	1.65
S1736	600	4000-10000	1.80
S1737	750	5000-12000	1.95
S1738	1000	7900-15000	2.30
S1739	1250	9750-19500	2.55
S1740	1500	14500-26500	2.70

HOW TO ORDER

Order from this page. Please give number, description and price of the articles you order to help us avoid mistakes. Total the amount of your order and send Post Office money order, certified check or draft with your order. Be sure to give your name and street address on both letter and envelope. Do not include money for transportation. We pay it. For other items see ads of November and December.

VACUUM TUBES

Genuine Cunningham Tubes. Every tube guaranteed new and in original package. We do not sell "bootleg" tubes.
SC200—Detector $4.45
SC201—Amplifier 5.95

MAGNAVOX

The genuine S-3 Radio Magnavox with the 14 inch horn is the ideal loud speaker for use in homes, offices, amateur stations, etc. It operates from your 6 volt storage "A" battery and amplifier as it reproduces. "B" battery voltage should be 90 to 200 for best results. "Radio brings it, Magnavox tells it."
S170—Radio Magnavox $39.50

METAL AND BAKELITE SOCKETS

Bakelite brown finished socket for panel or base mounting. Double spring contacts held rigidly in place.
S1076—Bakelite socket. $0.65
S1075—Nickeled metal socket ..... .45

VACUUM TUBE RHEOSTATS

This is a reasonably priced, smooth acting rheostate that will mount directly on back of panel. Bakelite arrow knob.
S1050—Rheostat 45c
Genuine Cutler Hammer rheostats, we believe, are the best rheostats on the market today.

Arranged for panel mounting. The picture shows the vernier type. All metal parts nickeled.
S1061—Vernier type C. H. Rheostat ..$1.40
S1062—C. H. Rheostat without vernier. .95

GRID AND PHONE CONDENSERS

Mounting holes spaced to fit screws of above Grid Leak. Mica insulation, wrapped with varnished cambric tape. Capacity, .00025 Mfd.
S55—Grid Condenser 15c
S59—Phone Condenser .001 Mfd. 20c

VARIABLE GRID LEAK

Pencil mark type. Removable black enameled cap.
S50—Grid Leak 20c

SPAGHETTI TUBING

For cabinet wiring. Yellow finish spaghetti.
S33—Per 4 ft length 27c
S32—Tinned Copper No. 16 Wire ..Ft. 2c
100 Ft. 75c

INSULATORS

These are very strong strain type Insulators.
S360—Moulded insulator shown above to left. Each, 10c; Doz. $1.10
S365—Porcelain insulator shown above to the right. Each, 9c; Doz. 95c

ANTENNA WIRE

The following are 100 foot coils of 7 strand cable of No. 22 wire, which makes the best Aerial. Use phosphor bronze, where the span is 100 feet or more. It is stronger.
S350—Stranded Phosphor Bronze, 100 ft. $1.47
S355—Stranded Copper, 100 ft. ..... .77
S356—Single No. 14 bare solid Copper Wire, 100 ft. ..... .42

LIGHTNING ARRESTER or PROTECTOR

Mounts indoors. Porcelain base, nickeled cover. Listed by the Underwriters' Laboratories under April, 1922, regulations.
S300—Protector $1.40

GREAT LAKES RADIO CO., 1124 JACKSON BOULEVARD CHICAGO, ILL.

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